BATTLEFORDS REGION TRANSPORTATION STUDY

EXECUTIVE SUMMARY

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BATTLEFORDS REGION TRANSPORTATION STUDY

EXECUTIVE SUMMARY

This Executive Summary presents the findings and recommendations of the Battlefords Regional Transportation Study and contains the results of the origin-destination (O-D) field studies and the results of the T-Model transportation model developed for the study area. The fifteen issues identified at the outset of the study are developed, evaluated and conclusions and recommendations made for each issue.

1.0 STUDY ISSUES

Highway 16 has been designated as the Yellowhead Route - a TransCanada Highway. It is ultimately intended to upgrade the Highway 16 within the study area to a four lane divided rural expressway with limited access. Two differing funding scenarios are studied. The first is the implementation of the proposed National Highway Policy which would provide federal government funds directly for the identified highway network of which Highway 16 in the Battlefords area is a segment. The second funding scenario is to identify those projects which are warranted or necessary under traffic warrant evaluation criteria. These necessary upgrades would be funded by provincial of local governments, or a combination thereof.

There are fifteen roadway and intersection issues which were identified at the outset of the study. The location of each issue is identified numerically of Exhibit 1. These issues include:

1. Intersection of Highway 40 (East) and Highway 16.
2. Intersection of Highway 16B (Railway Avenue) and Highway 16.
3. Intersection Highway 16A (Battleford Road renamed Poundmaker Trail) and Highway 16.
4. Highway 16 twinning within the City of North Battleford.
5. Request for a ramp Highway 16 (West to Highway 4 (North).
6. Twinning of the Highway 16 North Saskatchewan River Crossing.

7. Reconstruction of Interchange Highway 16 with Highway 4 and 40 (South).
8. Highway 16 twinning west of the Town of Battleford.
9. Intersection of Highway 16B with Territorial Drive (East).
10. Intersection of Highway 16B with Territorial Drive (West).
11. Retention of Old North Saskatchewan River Bridge Crossing (Highway 16A).
12. Intersection of Highway 4 and Highway 40.
13. Intersection of Highway 40 with Highway 29.
14. Territorial Drive (West) Realignment.
15. Upgrading of Highway 16 limited access or the implementation of a bypass route.

2.0 STUDY DESCRIPTION

The study includes all provincial roads and highways within the study area as shown on Exhibit 1. For comparison purposes, some urban roads and intersection statistics are included.

The study has five objectives. These objectives are:

- To accommodate projected traffic volumes at an acceptable level of service.
- To maximize safety.
- To provide flexible staging.
- To maximize socioeconomic benefits and minimize environmental and related disbenefits.
- To minimize capital construction costs and maximize return on investment.

The study was divided into six phases. The phases are:

1. Mobilization
2. Data Collection and Analysis
3. Transportation Network Modelling

4. Development of Impact Analysis Factors
5. Development of Route Alternatives and Issue Analysis
6. Scenario Evaluation, Intersection Reviews and Recommendations

The study was conducted by staff of Reid Crowther & Partners Ltd., Swanson Transportation Consultants Ltd., Environmental Management Associates and HBT AGRA Limited. The Study Team was directed by a Saskatchewan Highways and Transportation Steering Committee with input from a local Advisory Committee.

Three public open houses were held during the course of the study to introduce the study issues, to solicit public input on the issues, to outline the possible solutions and to present the study recommendations.

3.0 TRAFFIC STUDIES

The development of the Battlefords regional highway network needed to service the travel demand over the 20 year planning period necessitates the gathering of a good data base that identifies current traffic patterns and traffic volumes. The traffic volume data is utilized to analyze traffic operations at key locations within the study area in order to identify the need and form of potential roadway improvements at these locations. In addition, the traffic data was used as the basis for the formation of a travel predictions model.

Field data gathered included automatic and manual traffic counts, intersection movement volumes and O-D information. The traffic volumes were collected to compliment existing traffic counts. Exhibit 2 presents the two way traffic volume counts for the study area. Vehicle classification counts were also taken. They are used to initialize the prediction model and to complete capacity calculations on each road link studied. The intersection volumes including turn movements were taken to evaluate level of service (LOS) and for accident analysis purposes. The O-D information was collected at roadside interview locations so that trip origins, destinations and purpose could be analyzed. This information allows the model to relate land use to work trips, shopping trips, tourist trips and thru trips. The location of the O-D interview stations is presented on Exhibit 2.

Analysis of the field data collected identified the following conclusions:

1. The roadway network link which is nearing capacity is the existing Highway 16 river bridge link between the Town of Battleford and the City of North Battleford.
2. The levels of service of the intersections studied indicated all intersections operated at overall LOS of B or better. Two intersections, Highway 16/Highway 40 (East) and Territorial Drive (West)/Railway Avenue (South) have single legs operating at LOS D. These intersections warrant some upgrading to become more effective and less accident prone. The existing LOS of all intersections studied is presented in Table 1 below.

Table 1
Current Intersection Operation - Levels of Service

Location	Control	Volume/ Capacity*	Average Level of Service (LOS)	Level of Service Worst LEG (Movement)
Highway 16/Battleford Rd.**	Unsignalized		A	A (SBL)
Highway 16/Highway 40 East	Unsignalized		B+	D (NBL)
Highway 16/Railway Ave.E.	Unsignalized		A	A (WBL)
Highway 16A/Battleford Rd.	Unsignalized		A+	A (NBL)
Territorial Dr./Highway 4 N.	Signalized	0.44	B	C (NBL)
Territorial Dr./Douglas Rd.	Unsignalized		A	B (EBL)
Territorial Dr./15 Ave.	Unsignalized		B+	C (EBL)
Territorial Dr./8 Ave.	Unsignalized		A-	C (EBL)
Territorial Dr./Railway Ave. E.	Signalized	0.32	B	B (EBL)
Territorial Dr./Killdeer Dr.	Unsignalized		A-	C (SBL)
Territorial Dr./Railway Ave. W.	Unsignalized		A	A (EBL)
Highway 4 S./35 St.***	Unsignalized		A-	B (WBL)
Highway 4 S./29 St.***	Unsignalized		B+	C (WBL)
Highway 4 S./22 St.***	4 Way Stop		B	B (EBL)
Highway 4 S./15 St.***	Unsignalized		A+	A (WBL)
Highway 16A/35 St.***	Unsignalized		A	A (SBL)
22 St./1 Ave.***	4 Way Stop		A-	C (EBL)
Territorial Dr./Clement St.	Unsignalized		A-	B (SBL)
Territorial Dr./S.Railway Ave.	Unsignalized		B-	D (WBL)

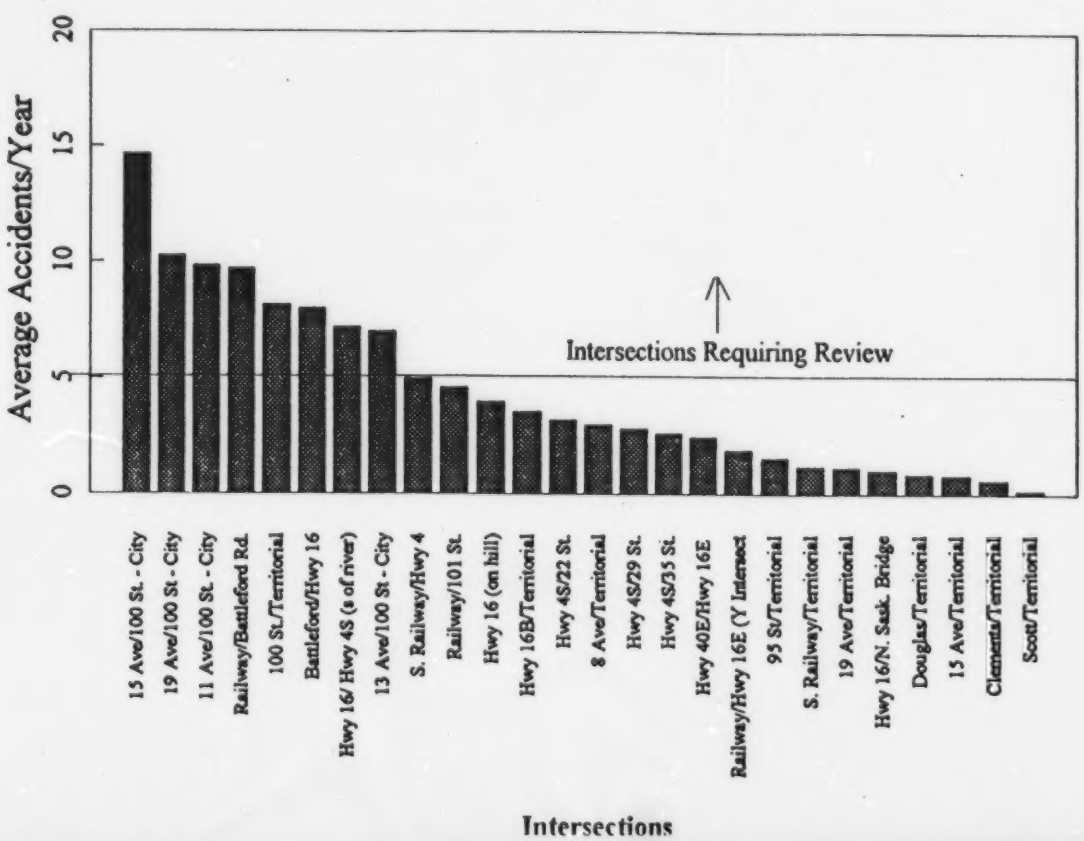
* V/C not reported for 4-way stop and unsignalized intersections

** Has overhead warning flashers

*** Town of Battleford; all others North Battleford

TABLE 2
INTERSECTION ACCIDENT OCCURRENCE
RANKED BY RATE OF AVERAGE NUMBER OF ACCIDENTS PER YEAR

Table 6.4 Subscript	Intersection	Average Accidents/Ye	Acc/Yr/AADT	Ranking Acc/Yr
A	15 Ave/100 St. - City	14.67	8.60	1
B	19 Ave/100 St - City	10.25	7.11	2
C	11 Ave/100 St. - City	9.83	5.21	3
D	Railway/Battleford Rd.	9.71	8.16	4
E	100 St./Territorial	8.14	5.99	5
F	Battleford/Hwy 16	8.00	7.92	6
G	Hwy 16/ Hwy 4S (s of river)	7.20	2.97	7
H	13 Ave/100 St - City	7.00	3.74	8
I	S. Railway/Hwy 4	5.00	4.51	9
J	Railway/101 St.	4.63	4.38	10
K	Hwy 16 (on hill)	4.00	N/A	11
L	Hwy 16B/Territorial	3.56	N/A	12
M	Hwy 4S/22 St.	3.20	2.86	13
N	8 Ave/Territorial	3.00	3.75	14
O	Hwy 4S/29 St.	2.80	1.63	15
P	Hwy 4S/35 St.	2.60	1.22	16
Q	Hwy 40E/Hwy 16E	2.45	3.89	17
R	Railway/Hwy 16E (Y Intersection)	1.88	N/A	18
S	95 St/Territorial	1.56	2.27	19
T	S. Railway/Territorial	1.20	1.11	20
U	19 Ave/Territorial	1.13	3.20	21
V	Hwy 16/N. Sask. Bridge	1.00	0.25	22
W	Douglas/Territorial	0.85	0.98	23
X	15 Ave/Territorial	0.80	1.07	24
Y	Clements/Territorial	0.60	0.78	25
Z	Scott/Territorial	0.15	0.19	26
	AVERAGE	4.43	3.56	

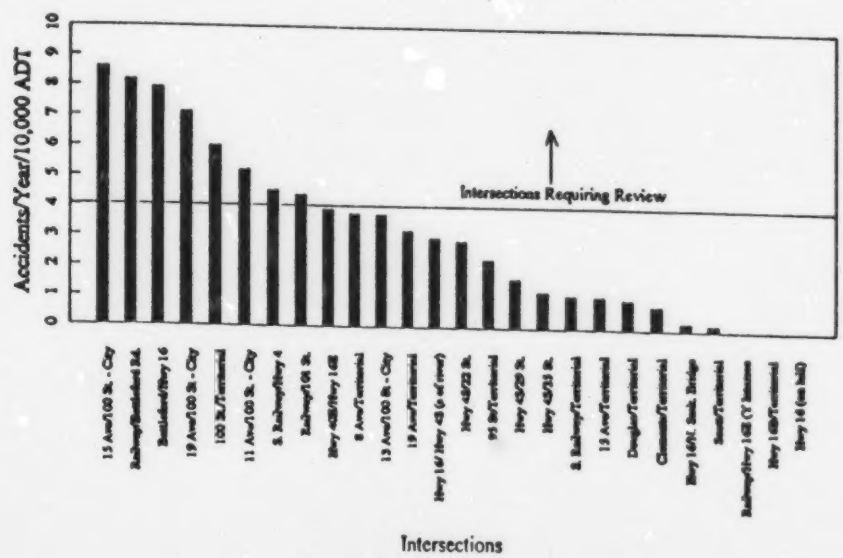


Accident analysis was conducted for intersections or road links perceived to have high accident rates. The twenty-five intersections and locations with the highest accident rates were analyzed. These intersections are ranked by the average number of accidents per year in Table 2 opposite and by number of accidents per 10,000 vehicles passing the accident locations in Table 3 below.

TABLE 3
INTERSECTION ACCIDENT OCCURRENCE
RANKED BY RATE OF ACCIDENTS PER YEAR AND PER TRAFFIC VOLUME

Intersection	Acc/Yr/AADT	Average Accidents/Year	Ranking by Accidents/Year
15 Ave/100 St. - City	8.60	14.67	1
Railway/Battleford Rd.	8.16	9.71	4
Battleford/Hwy 16	7.92	8.00	6
19 Ave/100 St - City	7.11	10.25	2
100 St./Territorial	5.99	8.14	5
11 Ave/100 St. - City	5.21	9.83	3
S. Railway/Hwy 4	4.51	5.00	9
Railway/101 St.	4.38	4.63	10
Hwy 40E/Hwy 16E	3.89	2.45	17
8 Ave/Territorial	3.75	3.00	14
13 Ave/100 St - City	3.74	7.00	8
19 Ave/Territorial	3.20	1.13	21
Hwy 16/ Hwy 4S (s of river)	2.97	7.20	7
Hwy 4S/22 St.	2.86	3.20	13
95 St/Territorial	2.27	1.56	19
Hwy 4S/29 St.	1.63	2.80	15
Hwy 4S/35 St.	1.22	2.60	16
S. Railway/Territorial	1.11	1.20	20
15 Ave/Territorial	1.07	0.80	24
Douglas/Territorial	0.98	0.85	23
Clements/Territorial	0.78	0.60	25
Hwy 16/N. Sask. Bridge	0.25	1.00	22
Scott/Territorial	0.19	0.15	26
Railway/Hwy 16E (Y Intersection)	N/A	1.88	18
Hwy 16B/Territorial	N/A	3.56	12
Hwy 16 (on hill)	N/A	4.00	11

Rate vs. AADT is in (accidents/million veh miles)



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The accident analysis leads to the following conclusions:

1. The average number of accidents per year has increased from 3.67 per year between 1980 and 1985 to 4.19 per year between 1986 and 1992.
2. Accidents occur uniformly throughout the months of the year and the days of the week.
3. 75% of all accidents occur during the day (6:00 A.M. to 6:00 P.M.). 55% of all accidents occur in the afternoon (12:00 P.M. to 6:00 P.M).
4. Weather is not a factor in most accidents.
5. Approximately 50% of all drivers involved in accidents are residents of the study area. Approximately 37% of accidents involve a non-study area driver. Approximately 11% of all accidents involve no study area drivers, i.e., both drivers are visitors.
6. 20 to 29 year olds have the most accidents.
7. 31% of accidents are right angle.
   24% of accidents involve a left turning vehicle.
   20% of accidents are rear end collisions.
   9% of accidents are single vehicle accidents.
   7% of accidents are sideswipes.
   9% of accidents are miscellaneous.
8. The five highest accident sites identified for the study taken from the list of issues are:
   1. Intersection of Territorial Drive (West) and Highway 16B (or Highway 4).
   2. Interchange of Highway 16 and Highway 4 (South).
   3. Intersection of 100th (Highway 4 North) and Territorial Drive.
   4. Intersection of Battleford Road and Railway Street (Highway 16B).
   5. Intersection of Highway 16 and Battleford Road.

The O-D information is divided into three categories of trip by vehicle type for each interview station. Thru trips are those which do not stop within the study area. Thru-stop trips are those which are highway thru bound trips which stop within the study area for one of many reasons. Non-thru trips are those which begin within the study area and have a destination outside the study area. This trip

Table 4
Trip Type and Vehicle Type by Station
(interviews - Outbound - 7:30 a.m. to 6:00 p.m.)

Trip Movements	Station 1 - Highway 4 North					Station 2 - Highway 40 East					Station 3 - Highway 16 East				
	Cars	Trucks	Buses	Total	% of Total	Cars	Trucks	Buses	Total	% of Total	Cars	Trucks	Buses	Total	% of Total
Non-Thru Trips (internal/external)	896	47	8	951	81.3%	251	20	6	277	79.6%	520	30	4	554	48.7%
Thru-Stop Trips	59	7	0	66	5.6%	39	6	1	46	13.2%	180	36	0	216	19.0%
Thru Trips	132	21	0	153	13.1%	15	10	0	25	7.2%	265	100	2	367	32.3%
Grand Total	1087	75	8	1170	100.0%	305	36	7	348	100.0%	965	166	6	1137	100.0%
Total of Thru and Thru-Stop				*219*	*18.7%*				*71*	*20.4%*				*583*	*51.3%*

Trip Movements	Station 4 - Highway 4 South					Station 5 - Highway 40 West					Station 6 - Highway 16 West				
	Cars	Trucks	Buses	Total	% of Total	Cars	Trucks	Buses	Total	% of Total	Cars	Trucks	Buses	Total	% of Total
Non-Thru Trips (internal/external)	287	76	18	381	89.6%	633	33	7	673	87.3%	286	56	12	354	42.7%
Thru-Stop Trips	9	4	0	13	3.1%	47	7	0	54	7.0%	135	45	1	181	21.8%
Thru Trips	18	13	0	31	7.3%	37	5	2	44	5.7%	187	106	2	295	35.5%
Grand Total	314	93	18	425	100.0%	717	45	9	771	100.0%	608	207	15	830	100.0%
Total of Thru and Thru-Stop				*44*	*10.4%*				*98*	*12.7%*				*476*	*57.3%*

Table 5
Daily Trip Movements by Station (External to External)
Thru and Thru-Stop Trips Combined*

Trip Movement		Trips To						Totals
		Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	
TRIPS FROM	Station 1 4 North		4	189	11	29	6	239
	Station 2 40 East	19		8	1	13	58	99
	Station 3 16 East	154	12		13	78	618	875
	Station 4 4 South	31	3	16		7	16	73
	Station 5 40 West	16	16	55	3		1	91
	Station 6 16 West	29	56	658	12	6		761
	TOTALS	**249**	**91**	**926**	**40**	**133**	**699**	**2138**

type was identifiable because the stations interviewed vehicles leaving the study area only. The conclusions reached from this data are as follows:

1. Highway 16 East (Sta 3) and Highway 16 West (Sta 6) have the highest thru and thru-stop trips passing through the station.
2. Highway 4 South (Sta 4) and Highways 40/29 West (Sta 5) have the lowest combined thru and thru-stop trips.
3. Highway 16 East/West have approximately one third of all the thru and thru-stop trips for all stations combined.
4. The highest combined thru and thru-stop movement occurs on Highway 16 East/West and the second then being Highway 16 East/Highway 4 North.

Table 4 opposite presents the percentage of vehicles at each station and the trip type of the vehicle. Table 5 opposite presents the thru and thru-stop trips for internal-external trips from station to station.

The purchase of gasoline was the most frequent reason for stopping within the study area.

Table 6 below presents the primary trip stop purposes for all O-D interviews.

Table 6
Thru-Stop Trip Purpose

Purpose	Percent of Total
Gas	39
Eat	22
Business Stop	14
Coffee	9
Shopping	6
Rest/Bathroom	4
Social	2
Personal Business	2
Drop Off/Pick Up Passenger	2
Total	**100**

For internal/external trips, the greatest numbers occur on Highway 4 North followed by Highway 16 East. Table 7 below presents the number of outbound urban trips generated on each provincial highway.

Table 7
Outbound (Internal/External) Trips
(Daily One-way Trips)

Route	One-Way Trips	% of Total
Highway 4N	1130	26.5
Highway 16E	963	22.6
Highway 16W	692	16.3
Highway 40	616	14.5
Highway 4	454	10.7
Highway 40E	396	9.4
Total	**4251**	**100.0**

A screen line count for trips crossing the river was undertaken which concluded that 85% of all trips crossing the river are trips being made between the two communities. Almost all trips on the Highway 16A bridges are inter-community. Approximately 15% of traffic crossing the river uses Highway 16A. Table 8 below presents by trip type the numbers of vehicles crossing each bridge.

Table 8
Bridge (Internal Screen Line) Trips

	Interviews	Int./Int. (% of Total)	Int./Ext. (% of Total)	Ext./Ext. (% of Total)
Station 7, Hwy 16A, Old Battleford Bridge (Two Way)	1520	1289 (84.8)	215 (14.1)	16 (1.1)
Station 8, Hwy 4E/ Hwy 16W, Northbound Ramp	1042	670 (64.3)	345 (33.1)	27 (2.6)
Station 9, Hwy 4E/ Hwy 16W, Southbound Ramp	1720	1129 (69.6)	544 (31.6)	47 (2.8)

Truck loads information was collected with empty trucks being the largest segment of the outbound truck traffic. Table 9 below presents the truck commodity statistics by interview station.

Table 9
Highway Truck Commodity

Load	Station						Sum	% Total
	1	2	3	4	5	6		
Empty	24	17	29	11	12	22	115	22
Gen. Merchandise	3	4	27	1	6	27	68	13
Groceries	11	0	19	2	3	14	49	9
Machinery	9	4	7	1	5	22	48	9
Grain	10	3	7	1	2	8	31	6
Livestock	5	2	8	1	3	8	27	5
Fuels	9	2	9	0	4	2	26	5
Lumber	1	0	20	1	3	0	25	5
Building Materials	1	1	6	3	3	11	25	5
Fertilizers	4	1	8	1	1	3	18	3
Farm Products	4	0	3	1	2	4	14	3
Furniture	0	0	4	0	0	9	13	3
Cement	2	0	1	6	2	1	12	2
Petro Chemicals	0	0	3	0	2	4	9	2
Autos/RVs	0	0	2	0	1	7	10	2
Bulk Materials	2	0	2	3	1	1	9	2
Miscellaneous	0	1	5	1	0	1	9	2
Service Trucks	2	1	0	0	2	3	8	2

4.0 TRAFFIC DEMAND MODELLING

The development of a computer traffic demand model was undertaken in order to test various road network options. The model facilitates testing several network options in succession to determine which road links are most likely to be used by traffic. The attributes of each road link such as capacity or design speed, can be varied to test the impact of road upgrades on the traffic patterns.

The computer model is also used to predict traffic volumes on each link given specific traffic growth projections.

Table 10
Battlefords Transportation Study
Population and Employment Data

	EXISTING (1992 CENSUS)		FUTURE (20 YEARS)	
Model Zone	Population	Employment	Population	Employment
1	560	0	560	0
2	275	18	375	18
3	590	41	590	41
4	1130	13	1130	13
5	600	0	600	0
6	590	14	590	14
7	615	76	615	76
8	395	39	395	39
9	400	83	400	98
10	940	6	940	6
11	605	24	605	24
12	875	21	875	21
13	350	346	350	346
14	350	265	350	265
15	605	16	605	16
16	840	46	940	46
17	655	188	655	188
18	335	1896	335	2410
19	890	435	890	500
20	0	99	0	220
21	655	42	655	42
22	0	324	0	384
23	0	250	0	295
24	457	0	1000	0
25	0	400	0	450
26	700	15	700	15
27	740	30	740	55
28	730	0	730	0
29	0	258	0	318
30	740	20	1240	20
31	480	40	665	40
32	260	0	425	0
33	0	645	0	645
34	0	235	0	335
35	0	152	0	152
36	0	373	0	438
37	0	172	0	192
38	0	639	0	639
39	0	386	0	536
40	645	0	1400	0
41	830	3	1580	3
42	565	0	565	0
Total	**18402**	**7610**	**21500**	**8900**

The model zones are presented on Exhibit 3. The population and employment figures for the existing zones is presented in Table 10 opposite.

Population and employment projections were developed for the 20 year horizon. Growth rates for the City of North Battleford and the Town of Battleford were established at 0.5% and 1.5% respectively. This is a reduction in the previously used City rate which was decreased due to slow-downs being experienced in the local economy dependent upon agriculture, oil and manufacturing. The resulting future population and employment distributed by land use planning for the study area are also presented in Table 10. Areas of expected growth are presented in Exhibit 4.

Five future roadway network options were developed. These are:

Future #1	Existing roadway network.
Future #2	Existing network with Highway 16 upgraded to limited access expressway standards.
Future #3	Same as Future #2, however, with the Highway 16A bridge closed to traffic.
Future #4	The existing roadway network with a northeast bypass around the City.
Future #5	Same as Future #4, however, with the Highway 16A bridge closed to traffic.

These networks with their respective future traffic volumes are presented in Exhibits 5, 6, 7 and 8 respectively, for the forecast traffic volumes.

Design hour volumes are based on the forecast 30th highest hour traffic volumes. PM peak hour is based on 15.5% of AADT on Highway 16 and 14.5% of AADT on other roads.

Conclusions from analysis of the forecast traffic volumes include:

1. The existing Highway 16 bridge will fall below acceptable levels of service within the next five years at current growth rates.

2. Other than new roads necessary to serve new growth areas, very little roadway upgrading is warranted based on traffic volumes.
3. The Highway 16A bridge must remain open to traffic until another river bridge crossing is provided to maintain roadway capacity at acceptable levels of service.
4. There is a traffic warranted need to signalize the Highway 16/Highway 40 (East) intersection in the short-term.

5.0 EVALUATION AND RECOMMENDATIONS FOR THE STUDY ISSUES

This section presents the conclusions derived from field study and modelling for each for the study issues. The issue is then evaluated in terms of relevant factors and recommendations made. At the end of this section there is a summary of the issues with the recommendations, estimated capital costs and trigger events which can be monitored to indicate implementation timing. The larger projects have been staged both for construction at the location as well as part of the overall project. Each issue is treated in the same numerical order as was originally identified.

5.1 Intersection of Highway 40 (East) and Highway 16

This intersection is currently operating at an overall LOS B+ with the Highway 40 leg at LOS D. The conclusion is that the Highway 40 leg requires attention based on traffic warrants. The options for this intersection include immediate signalization, implementation of Pioneer Avenue extension and/or relocation of Highway 40 to an intersection with Highway 16 at either Aberdeen Street or Hereford Street.

The analysis of the intersection has been completed under the two funding scenarios. The initial funding scenario is the implementation of the proposed National Highway Policy. This policy would require free flow on Highway 16 and therefore, the signalization of the intersection would be only a short-term solution. Under this policy, the relocation of the intersection to Aberdeen or Hereford Streets requires implementation.

Study of the question of whether to relocate to Aberdeen or Hereford Streets provides the following conclusions:

- The Aberdeen Street connection will be more expensive because a tight diamond with retaining walls in all four quadrants will be required.
- To provide all movement access to the industrial area south of the CN track will require additional structure clearance over the railway, increase the interchange costs and require the removal of the existing spur line.
- Visitor sightlines and access to local tourist destinations is limited by this interchange construction.
- Highway 40 relocation will impact the Laird Campground layout.
- The Hereford Street intersection can be more easily staged beginning at-grade and being grade separated when traffic volumes warrant.
- Pioneer Avenue construction is not as urgent, as the Highway 16 traffic volumes are lower at Hereford Street and the level intersection will remain acceptable longer.
- Staged implementation and the interchange construction are easier and less costly at Hereford Street.
- The grade separation of the railway crossing is not required at Hereford Street.
- Land use planning is less structured and more control can be exercised in the surrounding area development to be consistent with the interchange.

In the second funding scenario, where free flow is not required on Highway 16, analysis provides the following conclusions:

- The intersection will operate at acceptable levels of service with minor modifications and signalization for many years.
- The minor modifications to the intersection include improved traffic movement channelization and development of a "bulbed" service road connection design.

The recommendations for this intersection are as follows:

1. Implement intersection improvements and signalization. See Exhibit 9.
2. If policy requires free flow, relocate intersection to Hereford Street initially at-grade and ultimately as an interchange. See Exhibit 10.
3. Construct Pioneer Avenue extension from Territorial Drive East to existing Highway 40 coincident with or immediately after Highway 40 relocation.
4. Provide right-in/right-out movements only at existing intersection location.

5.2 Intersection of Highway 16 and Highway 16B (Railway Avenue)

This intersection is currently operating at LOS A with a low priority resulting from accident statistics. Investigation of the intersection indicates there is a local perception that this is an unsafe intersection.

Under the free flow requirements of the National Highway Policy this intersection will become an interchange because of the requirement for free flow across the adjacent railway track. City destined traffic can be provided with an off-ramp for Highway 16 westbound to access Railway Avenue and a return ramp to Highway 16 eastbound. This construction will require closure of the existing service road paralleling Highway 16.

Analysis under the non-free flow policy indicates the following conclusions. The intersection can operate as is for the study period. The signing, lighting and pavement markings can be improved to improve the driver's understanding of the intersection. In due time, it may become necessary to give right-of-way to Highway 16 westbound traffic over Railway Avenue eastbound.

The recommendations for this intersection are as follows:

1. Implement minor improvements including upgraded directional signing, improved street lighting, improved regulatory and general signing and improved road surface traffic markings.

2. If policy requires, develop the interchange. See Exhibit 11. The on and off-ramps are optional and will depend on whether the next interchange location is an extension of Territorial Drive (East or if it is located at Battleford Road. Implementing the inbound ramp will require closure of the frontage road.

5.3 Intersection of Highway 16 and Highway 16A (Battleford Road)

This intersection is currently operating at LOS A. It has warning flashing lights on Highway 16 due to its accident record. It is an intersection for which improvements are warranted based on accident statistics.

Analysis of the intersection indicates there is sufficient storage length at acceptable grades for the installation of signals without profile changes. The majority of accidents involve vehicles crossing Highway 16 or turning left onto Battleford Road in collision with through bound vehicles.

If the free flow policy is adopted, the signalization will not be a long-term solution. In this case, the long-term solution is to develop an interchange at this intersection or by extending Territorial Drive to Highway 16 and providing service roads to access the highway service establishments.

Analysis of the possible solutions for an interchange at this intersection indicate a point diamond or a partial split diamond can be developed without impacting the adjacent highway service establishments. There is approximately a $600,000 premium to adopt the point diamond solution. Traffic operations of either solution would be acceptable. There are significant geotechnical concerns related to the north escarpment of the North Saskatchewan River Valley. These are related to stability of the hillside and the developments at the top of the bluff. These require extensive investigations to prove the feasibility of this proposed interchange and the twinning of Highway 16 down the escarpment. There is a $1.0 million premium included in the capital cost estimates to mitigate the geotechnical concerns related to this section of twinning and interchange development.

Should the interchange location be proven unfeasible, an interchange can be developed by extending Territorial Drive (East) to Highway 16. This location would require the off-ramp for westbound vehicles from Highway 16 to Highway 16B (Railway Avenue) for westbound vehicles. Their return to westbound traffic would be via the extended Territorial Drive and then via an on-ramp south of the Tropical Inn. Eastbound access would be provided via an off-ramp near Battleford Road which would access the service road south of Highway 16 and then via the extended Territorial Drive to the City. The return movement would be via the south service road or via a ramp parallel to the railway from Highway 16B (Railway Avenue). This interchange is very difficult to sign and provide ease of access to and from the city.

The recommendations for this intersection are as follows:

1. Place additional flashing lights and signing on Highway 16 indicating the speed zone restriction and an "Important Intersection Ahead".
2. Implement signals to increase safety for the north/south crossing traffic and the left turning traffic. This installation should be reviewed if the Highway 16A bridges are closed to thru traffic.
3. If the proposed National Highway Policy is adopted, proceed immediately with further geotechnical investigation to confirm the suitability of the location for an interchange and the requirements for twinning Highway 16 down the escarpment. The partial split diamond is recommended as it is less costly. See Exhibit 12. If the interchange location is proven geotechnically unfeasible, implement the extension of Territorial Drive and its associated interchange. See Exhibit 13.

5.4 Four Laning Highway 16 from Highway 16B (Railway Avenue) to the North Saskatchewan River

This section of Highway 16 is currently a two lane undivided road with at-grade intersections at the Highway 16B connection and at Battleford Road. The section traversing the north escarpment of the river valley is unstable, probably requiring additional monies for geotechnical mitigation during construction.

Analysis of projected traffic volumes indicate that twinning is not warranted.

The recommendation for four laning (east) is as follows:

1. Twinning is not warranted unless policy is implemented to dictate.

5.5 Return Ramp to North Battleford at Highway 16 and Highway 4 (North)

Highway 16 and Highway 4 (North) intersect at a partial grade separation immediately north of the river bridge. The majority of the interurban traffic using this river crossing use Highway 4 to the City rather than continue on Highway 16 eastbound. Traffic uses Highway 4 as it completes the return movement. The partial interchange was established to join the two traffic streams and not to provide directional movements between the roadways.

Analysis using the computer traffic model indicates that at the horizon year only five vehicles would be attracted to a directional ramp from Highway 16 westbound to Highway 4 northbound. This traffic volume does not warrant construction of the ramp.

The recommendation for the return ramp is as follows:

1. Do not construct the ramp.

5.6 North Saskatchewan River Crossing

The existing two lane, two direction bridge is operating at LOS D at peak hour with existing traffic flows. This bridge is the prime emergency vehicle artery between the two urban areas. The bridge accommodates wide loads which cause the short-term closure of the bridge to traffic in the opposing direction. This can have a serious impact on emergency services. If the bridge were impassable, the only alternate route is the Highway 16A bridges.

The screen line river crossing counts indicate that there is sufficient river crossing capacity in the combined old bridge (16A) and the new single bridge (16) to

accommodate traffic projections beyond the horizon of this study. The LOS of the Highway 16 bridge will, however, likely remain at LOS D or lower before traffic is forced to use the Highway 16A bridge. The use of the Highway 16A bridge will increase traffic on streets within the Town of Battleford.

There are three options for upgrading the river crossing capacity:

Option 1	Twin the existing Highway 16 bridge.
Option 2	Provide a new bridge on a bypass route.
Option 3	Upgrade the Highway 16A bridges.

Option 1 is compatible with the proposed National Highway Policy in that it provides for twinning of Highway 16. The traffic accommodated by the two lane unidirectional bridges exceeds the 20 year projection of this report. It also provides an alternate access for emergency vehicles, should one bridge be impassible. The adjacent roadway realignments would also allow remediation of the restricted speed curves off the north approach for the bridge on Highway 16. This is a known crossing area of the river and geotechnical analysis and prediction will have a higher level of confidence. Known environmental areas and factors will not be affected.

Estimated capital cost is $7.0 million.

Option 2 is compatible with the proposed National Highway Policy in that it provides for free flow traffic on a new bridge on a Highway 16 bypass. The new bridge will have sufficient capacity for highway traffic beyond the study horizon.

The existing bridge will improve to LOS C traffic conditions, but decay to LOS D or E during the study term. The additional traffic capacity of Highway 16A bridges will be required to maintain traffic volumes across the river in the urban area. The Highway 16A bridges will also be required for emergency access if the Highway 16 bridge is closed.

The location of the proposed bypass river crossing can allow for the closure of the smaller river channel. This would reduce the cost of the river bridge significantly, however, approval from federal and provincial environmental ministries will be required.

Estimated cost of short bridge alternate plus repairs to Highway 16A bridges is $10 to $12 million.

Option 3 upgrading and reconstruction of the existing Highway 16A bridges will provide sufficient capacity between the two urban centres. It will not however, assist with improving the level of service requirements or capacity required by the proposed National Highway Policy. This option will create the effect of shortcutting traffic through the Town of Battleford.

The estimated costs of this option are as follows:

Reconstruction	$8 million
Partial reconstruction for thru traffic	$2 million
Reconstruction for recreational traffic	$0.8 million

Conclusions from the analysis are:

1. The existing Highway 16 bridge will shortly exceed acceptable levels of traffic congestion.
2. To upgrade the Highway 16A bridges to accept the overflow traffic will cost a minimum of $2 million and cause traffic problems in the Town of Battleford.
3. Free flow traffic conditions can be met by either twinning the existing Highway 16 bridge or installing a bypass bridge.
4. Emergency traffic requires the Highway 16A bridges remain in use unless the Highway 16 bridge is twinned.
5. The Highway 16 twinning is the least cost alternative and it provides the road network with the most benefits.

Recommendations for the North Saskatchewan River crossing are as follows:

1. Begin immediately to plan for twinning the existing bridge if the bypass route is not selected.
2. If the bypass route is selected, begin planning to upgrade the Highway 16A structures to maintain thru traffic.
3. If the Highway 16 bridge is twinned, close the Highway 16A bridges to thru traffic after opening of the twin structure.
4. Increase the radius of the curves immediately north of the bridge to a 500 metre radius at a design speed of 115 km/h.

5.7 Reconstruction of Highway 16 and Highway 4/40 (South) Interchange

The existing interchange has been designed for the two lane Highway 16 it currently serves. All ramps and mainline are operating at acceptable levels of service.

Analysis of accident statistics indicate it does not warrant immediate attention. Forecast traffic volumes indicate the interchange will be at capacity by the end of the forecast period.

The recommendations for this interchange are as follows:

1. If the proposed National Highway Policy is implemented, the interchange should be reconstructed in the 3S configuration of previous reports.
2. If the bypass were implemented, this interchange will not require reconstruction until there is a need to twin the current Highway 16 bridge.
3. If the proposed National Highway Policy is not implemented, the existing bridge will require twinning in the short-term.

5.8 Twinning of Highway 16 (West)

Previous reports have recommended relocation of the single carriageway two lane section of Highway 16 between the Highway 4/40 interchange and the existing twinning west of the CNR crossing.

This relocation work is warranted by the proposed reconstruction of the interchange south of the river crossing. The new interchange requires that Highway 16 be relocated to allow implementation of an interchange design that meets current standards, allows for the new twinned river bridge and reduces accidents on the interchange roads.

The recommendation for twinning Highway 16 West is as follows:

1. Whether the proposed National Highway Policy is adopted and the river bridge is twinned or the river bridge is twinned on traffic volume warrants, twinning of Highway 16 west should follow immediately after opening the twinned river bridge and Highway 16/4/40 interchange.

5.9 Intersection of Highway 16B (Railway Avenue) and Territorial Drive East

The intersection of Highway 16B and Territorial Drive East is perceived to be a high accident frequency location. Traffic volumes at this location are relatively high due to the proximity of the Frontier Mall access road, the major link provided by Territorial Drive and the Highway 16 access.

Analysis indicates this is an intersection which requires review to reduce accident frequency. The Territorial Drive leg is complicated by the proximity of the service road intersection and by the downgrade towards the Highway 16B intersection. Left turns from Highway 16B to Territorial Drive are also frequently involved in accidents.

The recommendations for this intersection are as follows:

1. Reduce the speed limit on Territorial Drive.
2. Close the access road intersection when Pioneer Avenue is extended East to provide commercial access along the north side of the mall.

5.10 Intersection of Highway 16B/Highway 4 with Territorial Drive West/ Railway Avenue South

This intersection is very wide in the east-west axis to accommodate the twinned Highway 4 to the south and Highway 16B in the City of North Battleford. This intersection was identified as having a high accident frequency.

Analysis of accident statistics indicate that this intersection is among the five high accident rate intersections in the study area. Accidents tend to be north or southbound vehicles in collision with vehicles crossing the highway or twinning left onto the highway. Analysis of profiles indicate that the northbound carriageway is hidden below the median and eastbound vehicles or left turns to the north from Territorial Drive have a restrictive sightline to oncoming traffic. Similarly, the curve immediately north of the CNR overpass structure and the overpass itself gives a restricted sightline for southbound vehicles.

The recommendations for this intersection are as follows:

1. Reduce the speed limit on Highway 4 and enforce the reduction.
2. Remove the tree in the northwest quadrant which is within the sightline triangle in the northwest quadrant.
3. If the accidents continue, control through four way stops or signalization may be required to reduce accident frequency.

5.11 Highway 16A River Crossing Bridges

The Highway 16A river crossing bridges were constructed for the initial highway route through the Battlefords area. They are a structural steel truss design which span from the south bank to Finlayson Island and in a second bridge from Finlayson Island to the north bank. The bridges are capable of accommodating daily traffic and emergency vehicles. The traffic lanes are very narrow by current standards and reduced speeds are warranted. The bridges are in need of general repair such as repainting as well as some specific repairs to decking and

foundations. There are three options available with respect to the bridges. These are:

1. Minimal repairs to allow pedestrian traffic and light recreational vehicle access to Finlayson Island.
   Estimated cost is $800,000.
2. Repairs including structural repairs to allow use by normal, everyday traffic at the reduced traffic volume capacity dictated by the narrow traffic lanes.
   Estimated cost is $2,000,000.
3. Reconstruction of the bridges to current standards as a two lane bridge, effectively twinning the existing upstream Highway 16 structure.
   Estimated cost is $8,000,000.

Analysis of the alternatives includes the intended use of the road under each, traffic impacts, land use impacts and economics of the regional transportation plan.

The complete closure of the bridges was not considered in this analysis due to the requirement to provide recreational access to Finlayson Island.

The restriction of service on one or both of the bridges to pedestrian, cyclist and light recreational traffic to Finlayson Island can only be considered if the Highway 16 bridge is twinned at its existing location to ensure emergency access between the two urban areas. The restriction to non-thru traffic would occur immediately after the opening of the twin bridge. The traffic impact would be a reversal of traffic direction within the Town of Battleford and the reduction of thru or shortcutting traffic. The reversal of the commuter traffic flow will ultimately require the collector road intersections with Highway 4 being signalized to accommodate traffic movements. Traffic movements at the Highway 16/Battleford Road intersection change from cross traffic movements to right and left turn movements. The traffic volumes at this intersection are lower once Highway 16A is closed to thru traffic, however, the intersection will require signalization to accommodate the turn movements.

Maintaining of the Highway 16 bridges would be necessary for traffic volume capacity across the river, recreational access to Finlayson Island and emergency access if the current Highway 16 bridge is not twinned in the urban area. Traffic volumes on the collector roadways within the Town of Battleford would increase as traffic is diverted from the Highway 16 bridge to the 16A bridges due to traffic congestion on Highway 16. The intersection of Highway 16/Battleford Road would become more congested and require signalization within the planning horizon of this report.

The construction of new 16A bridges is not considered appropriate, as the cost of this alternative exceeds the cost of twinning the Highway 16 bridge and the traffic impacts of directing large volumes to the 16A route would cause serious traffic congestion in the Town of Battleford.

In conjunction with the proposed National Highway Policy, the long-term net present worth of the $800,000 and $2,000,000 expenditures is the same.

The recommendation for Highway 16A river crossing bridges is as follows:

1. To retain the Highway 16A bridges for recreational access only unless a requirement exists for emergency access. This will minimize the traffic impacts on the Town of Battleford. It is inevitable that should the communities continue to grow, the existing Highway 16 bridge will require twinning, although it is beyond the planning horizon of this report if the Highway 16A bridges remain open to thru traffic. It serves the communities better to proceed at an earlier date with the bridge twinning and the interchange reconstruction. Traffic capacity is increased immediately, accident prone roadway locations are upgraded and a more uniform driving condition is provided.

5.12 Intersection of Highway 4 and Highway 40 (South)

This intersection was identified as an accident prone location. It is the intersection of two rural highways in an urban fringe environment which mixes high speed rural travellers with low speed urban travellers. Particularly, Highway 4 as it only skirts the urban area does not require its travellers to perceive the need to slow down.

Analysis of the intersection indicates a low accident frequency with minimal injuries.

Additional investment of money is not warranted at this time based on prioritizing local needs. If local perception requires additional improvement, then addition of median flashing lights and signs could be implemented.

The recommendation for this intersection is as follows:

1. Leave the intersection in its current configuration.

5.13 Intersection of Highway 40 and Highway 29

This T-intersection of Highway 29 and Highway 40 occurs on a downgrade and a horizontal curve. The embankment cuts were constrained by the right-of-way and sight triangles have not been cleared. The intersection has had four accidents over the past five years. Highway 29 is a low volume road which also serves nearby county residential developments. The intersection and adjacent roads are shown in Exhibit 14.

Analysis indicates that the intersection on a curve at the bottom of the hill contradicts good roadway engineering practice. Sightline clearing will aid in driver's sighting of entering vehicles. It is not practical to move the curve or regrade the profile. Relocation of the intersection to a location further west approximately 1 kilometre to a tangent road with good sightlines, would be beneficial. This would require the country residential drivers to lengthen this one way trip by between 2 and 3 kilometres. Cost benefit analysis indicate the

relocation is not warranted given a 20 year horizon. The proposed relocation is shown on Exhibit 14.

The recommendations for this intersection are as follows:

1. Costly relocation is not warranted at this time.
2. Sightline improvements, speed restricted zones and "Intersection Ahead" signs are low cost improvements which would aid in minimizing the accident potential of this intersection.

5.14 Relocation of Territorial Drive (West)

Territorial Drive on the west side of the City of North Battleford returns east to intersect with Highway 4 south of the CNR Hamlin line. Territorial Drive passes through a subway under the CNR track to Lloydminster. It is proposed to relocate Territorial Drive further south to intersect with Highway 4/16 below the major portion of the north side river escarpment adjacent to a Ducks Unlimited project. The route of the relocation is presented on Exhibit 15.

Analysis indicates the alignment, profile and geometry are feasible. Geotechnical assessment indicates that the escarpment slope is potentially unstable and costly mitigation efforts would be required to ensure the road embankments did not create the potential for a slippage zone. The road alignment would have some impact on the Ducks Unlimited project, however, this should be minimal. To include all traffic movements at the proposed intersection location, it would be necessary to construct a flyover directional ramp from Territorial Drive eastbound to Highway 16 eastbound.

The relocation would see the cost of the existing road and railway subway became a "lost" cost. The residential lots released by this relocation are the only justification for the project as roadway economic analysis indicates it to be a non-economic project. The intersection would ultimately be signalized to accommodate the movements in safety.

Table 11

Conceptual Construction Description of Alignment Options

Br - Bridges
Int - Interchanges

Option #	Length	Sunk Costs	New 4 Lane	New 2 Lane	Interchanges	Bridges	Major Int.	Estimated Costs
1.	29 km	5.5 km twinning	14 km	0 from Brada 2 km to Highgate	Highway 16E Highway 16W 4N	N. Saskatchewan 1.0 - 1.2 km 2 small Battle Creek	45 29	Sunk 2.2 New 12.0 Br 36.0 Int 10.4 60.6
2.	27 km	4 km twinning	12 km	0 from Brada 2 km to Highgate	Highway 16E Highway 16W 4N	N. Saskatchewan 3 bridges @ 300 m	45 29	Sunk 1.6 New 10.4 Br 29.7 Int 10.4 52.1
3.		Not feasible						
4.	28 km	-	-	0 from Brada 3 km in N. Battleford 2 km to Highgate	CN, Battleford Rd. 4N, 40N	N. Saskatchewan 450 m (2 lane)	-	Sunk 0.0 New 6.0 Br 7.4 Int 24.7 38.1
5.	27 km	4 km E. N. Battleford 7.5 km W. Battleford	21 km	0 from Brada 2 km to Highgate	Highway 16E Highway 16W 4N	N. Saskatchewan 700 m RR - 50 m x 2	40	Sunk 3.0 New 16.8 Br 25.1 Int 3.5 48.4
6.	27.8 km	4 km E. N. Battleford 7.5 km W. Battleford	21.75 km	0 from Brada 2 km from Highgate	Highway 16E Highway 16W 4N	N. Saskatchewan 700 m (or 450 m) RR - 50 m	40	Sunk 3.0 New 18.2 Br 23.1 Int 3.5 47.8 (Close Channel) (40.9)
7.	30 km	4 km E. N. Battleford 7.5 km W. Battleford	24 km	0 from Brada 1 km from Highgate	Highway 16E Highway 16W 4N	N. Saskatchewan 700 m RR - 50 m	40	Sunk 3.0 New 19.6 Br 23.1 Int 3.5 49.2

The recommendation for relocation of Territorial Drive (West) is as follows:

1. Given the potential to create an area of slippage on the escarpment, the cost of the project and the lack of roadway related benefits the project is not recommended.

5.15 Highway 16 Bypass Versus Upgrading of Existing Highway 16

The main question to be resolved regarding the local area roadway network is whether the upgrading of Highway 16 to the proposed National Highway Policy standards is a better solution for the regional roadway network or if a bypass road to the same standards is the better solution. The evaluation of the two alternates is based on first finding one or more feasible bypass routes and then evaluating the optional routes including upgrading the existing route. The evaluation factors for the options included the following factors:

- Environmental
- Socioeconomic
- Traffic
- Design Criteria
- Topography
- Geotechnical
- Estimated Capital Costs
- Other Factors Including Dangerous Goods Movement and Land Services

The evaluation factors were developed and assessed using quantitative criteria when possible and qualitative criteria for the remainder.

Six bypass routes were initially identified for the feasibility study, three to the southwest of the urban area and three to the northeast of the urban area. These route options are presented on Exhibit 16. The conceptual description of the six bypass routes and the upgrading of the existing route is presented in Table 11 opposite. The analysis of the conceptual alignments immediately identified Option 3, the shortest route, as unfeasible due to existing land uses. Route 1 and

Table 12
Alignment Option Factor Evaluation

Evaluation Criteria	Alignment Options						
	1	2	3	4	5	6	7
Environmental	Conflicts - Brada Project White Tailed Deer, Beaver Rouffled Grouse.	Same as Option 1	Not Feasible	Existing alignment, minimal environmental impact.	Does not impact any known environmentally sensitive area.	Same as Option 5	Same as Option 5
Socioeconomic	Bypasses major urban area, in favour of smaller urban centre.	Same as Option 1, reduces developable land area in Town.	Not Feasible	Keeps all traffic through existing highway commercial strip.	Provides bypass of current urban areas.	Same as Option 5	Same as Option 5
Geotechnical	Crosses unstable riverbank slope. Remainder on suitable material.	Same as Option 1	Not Feasible	Stability known concerns with existing North River escarpment.	Road building materials acceptable. River crossing location unknown, however, in proximity to stable RR crossing.	Same as Option 5	Same as Option 5
Topographical	Crosses river at wide flood plain, crosses railway track obliquely. Additional river crossings.	Multi-bridge crossing N. Saskatchewan River, crosses RR obliquely. disrupts built-up areas.	Not Feasible	Maintains existing crossing points of topographical constraints.	Crosses 2 RR tracks, new crossing of the river.	River crossing has the potential to be shortened.	Requires 2 river bridges and 1 RR crossing.
Roadway Design	Can achieve desired design criteria.	Can achieve desired design criteria.	Not Feasible	Can achieve roadway design criteria except at north end of river. Bridge speed reduced to 100 km/h.	Can achieve all roadway design criteria.	Same as Option 5	Same as Option 5
Traffic Warrants	Reduces traffic on existing Highway 16 route through urban area, reducing accidents and delays costly upgrading.	Reduces traffic on existing Highway 16. Potentially reduces accidents and delays costly roadway upgrading.	Not Feasible	Will alleviate all known traffic problems and provide for long-term traffic traffic volumes.	Reduces traffic on existing Highway 16. Potentially reduces accidents and delays delays costly road upgrading.	Same as Option 5	Same as Option 5 (Requires connection to Highway 378).
Cost	Total length: 29 km. Concept cost estimate: ± $60.6M	Total length: 27 km. Concept cost estimate: ± $52.1M	Not Feasible	Total length: 28 km. Concept cost estimate: ± $38.1M (least long-term maintenance costs requires additional $2.0M).	Total length: 27 km. Concept cost estimate: ± $48.4M	Total length: 28 km. Concept cost estimate: ± $47.8M (long br), ± 40.9M (short br).	Total length: 30 km. Concept cost estimate: $49.2M
General Impacts	Shortens dangerous goods movement in urban area. Severs several land parcels. Requires additional $2 million expenditure on Highway 16A bridge. *	Slightly longer dangerous goods route adjacent to urban area. Severs several land holdings. Requires additional $2 m expenditure on Highway 16A bridge.	Not Feasible	Has longest dangerous goods route in urban area.	Removes dangerous goods movement from urban area. Severs at least one land holding.	Same as Option 5. Impacts some dwellings.	Same as Option 5. Uses existing right-of-way for part of alignment.

* Not included in concept cost estimate.

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Route 2 were eliminated based on geotechnical concerns related to river escarpment stability, impact on environmentally sensitive areas, and high estimated capital construction costs. Routes 5 and 7 were eliminated primarily due to high estimated construction costs. Both of these routes included an additional railway crossing and long or difficult river crossing locations. Route Option 6 became the best of the bypass conceptual route options. Table 12 opposite presents a summary of the route option evaluation which was completed for the seven route options.

The net present worth of the options is presented based on two Highway 16A scenarios. These are:

1. Upgrade Highway 16 according to traffic warrants and do the minimum necessary to maintain traffic on the existing Highway 16A bridges.
2. Twin the Highway 16 river bridge immediately and close the Highway 16A bridges to traffic.

The two routes for study which remain following the factor evaluation, were the upgrading of Highway 16 on its existing alignment and the northeast bypass crossing the North Saskatchewan River immediately north of the CNR trestle bridge crossing. The detailed evaluation of the two routes is based on the criteria established for the proposed National Highway Policy, a four lane divided expressway, capable of a minimum operating speed of 90 km/h under free flow conditions.

The following is a brief description of the work programs associated with each of the two routes. Both routes are presented on Exhibit 17.

The bypass route, beginning to the east of the City of North Battleford, would turn north and follow the section line to the east of the airport. Exhibit 18 presents the conceptual design flyover necessary to maintain free flow conditions. Highway 40 would intersect the bypass at an at-grade intersection. It would proceed north along the section line to 1 mile south of Highway 387 where it would turn west to intersect Highway 4 at a diamond interchange. Exhibit 19 presents the conceptual design of this interchange. The bypass would proceed west crossing the railway

at-grade and then dropping into the river valley to cross the river and use the existing coulee to climb to normal grade. The river crossing can be shortened if re-directing of the lesser channel into the main stream can be accomplished. The bypass route would be grade separated from the railway on the west side of the river valley. The bypass would be constructed initially as a two lane highway and upgraded to four lanes near the end of the study horizon. The river bridge would not exceed two lanes during the study period. The bypass would rejoin Highway 16 at a flyover interchange immediately east of Highgate. Exhibit 20 presents the conceptual design of the flyover. This bypass route is approximately 2 kilometres longer than the upgrading route. The upgrading of the Highway 16A bridges would be required in approximately 10 years. A pedestrian crossing of the North Saskatchewan River would also be required.

The upgrading route would enter the east side of the City of North Battleford. Highway 40 would require relocation to the Hereford Drive intersection location as an at-grade intersection to maintain free flow on Highway 16. The signals recommended at the existing location would be a short-term solution until funding could be allocated to the relocation. When traffic warrants are fulfilled, the intersection would become an interchange to accommodate all the necessary traffic movements. Pioneer Avenue extension would be required prior to the flyover at the Highway 16/16B wye intersection. This flyover construction and associated ramp construction would require the closure of the existing commercial/retail frontage road. The decision regarding whether to build the Territorial Drive interchange or the Battleford Road interchange would be required when planning the wye flyover beginning. The twinning of the river bridge would be the first project in the upgrading. The completion of this project would allow flattening the substandard curves north of the river and the downgrading of the Highway 16A bridges to recreational uses only. Following the twinning of the bridge, the remainder of the twinning to the west would be completed and the reconstruction of Highway 16/Highway 4 interchange would be completed.

Detailed evaluation of the two routes provides the following results.

Known environmentally sensitive areas are avoided on both alignments. Further, detailed study will be required immediately prior to finalizing the bypass alignment.

The socioeconomic analysis centered on the impact of re-routing thru bound traffic to the bypass. This study did not attempt to measure the economic benefits accruing to the local economy from the highway traffic. Review of previously published reports on the impacts of implemented bypass routes indicate that the economic impacts vary with the increasing distance from the urban area. For bypasses which are a short distance, such as that on the proposed Option 6 alignment, literature suggests there will be little economic disbenefit to the region in terms of economics. Some business relocation of highway commercial business to convenient locations on the bypass will be experienced. Strong local public opinion was voiced at the public open houses, regarding the perception that a highway bypass would have a significant negative impact on local businesses.

This factor was not quantified and it was agreed to rate the bypass route lower for socioeconomic benefits than the upgrade.

Traffic projections were completed based on the O-D information and the known proposed land use changes. Proposed developments within the region will have little impact on road needs due to the increases in traffic volumes. All the interchanges indicated in the planning are warranted within the study period based on maintaining free flow traffic on Highway 16 in the upgrading scenario. Only signalization improvements were warranted on Highway 16 under the bypass scenario. The staging of traffic warranted projects was developed for both options. The bypass attracted little traffic even when it was assumed that highway commercial needs such as gasoline, restaurants and motels were available adjacent to the bypass. This leads to a poor return on investment due to overbuilding of infrastructure.

The upgrading of Highway 16 allows several accident prone intersections to be upgraded.

Table 13
Highway 16 Upgrading Cost Summary

Highway 16 Upgrades	Cost With 16A Bridge (millions)	Cost Without 16A Bridge (millions)
Right of Way	$0.3	$0.3
Hwy 40 Realignment & Pioneer Ave.	3.9	3.9
CNR Overpass	4.6	4.6
Twin from CN to Hwy 4	3.0	3.0
Interchange Hwy 16 & Battleford Rd.	8.0 *(7.4 Alt Design)	8.0 *(7.4 Alt Design)
Reconstruct Interchange South of River	6.4	6.4
River Bridge	7.0	7.0
Twin to West Study Limit	3.0	3.0
Hwy 40 Interchange	2.0	2.0
16A Bridge	2.0	0.8
Miscellaneous Small Upgradings	--	0.2
Total Project	40.2 (or 39.6)	39.2 (or 38.6)
NPW	$-320	$-320
IRR	18%	18%

* Costing has assumed reasonable cost implications to mitigate geotechnical concerns of known slope stability problems. Further investigation is required.

Table 14
Bypass Cost Summary

Bypass	Cost (1) (millions)	Cost (2) (millions)
Right of Way	$0.6	$0.6
Lost Cost of Twinning	3.0	3.0
Pioneer Avenue & Hwy 40 Realignment	3.9	3.9
Hwy 16 East Flyover	2.1	2.1
10 km of Bypass	11.3	11.3
Hwy 4 Overpass	2.0	2.0
Twin to River	2.4	2.4
River Bridge* and RR Overpass	16.0	10.0
3 km Road Plus West Flyover	4.2	4.2
Hwy 16A Bridge	2.0	2.0
Pedestrian Crossing of River in Battlefords	1.0	1.0
Total Project	48.5	43.0
NPW	$-340	$-330
IRR	19%	20%

* Note: Assumes four lane structure equal to existing bridge length.

Design criteria considerations reviewed indicate that the bypass route can be designed to 130 km/h criteria. The upgrading of the existing highway will have one curve for both carriageways restricted to 115 km/h, immediately north of the river. Otherwise, all design criteria can be met. The upgrading option is somewhat more curvilinear in design. The profiles are similar.

Topographic analysis indicates the routes are similar.

Geotechnical studies have identified potential instability in the North Saskatchewan River escarpment between Battleford Road and Highway 4. There has also been some historical evidence of movement in the south abutment of the Highway 16 river bridge. There has been a concern expressed about the implementation of an interchange at Battleford Road and the twinning down the side hill. An extensive geotechnical testing program has been identified to first, confirm the feasibility of these two road projects and second, identify mitigative measures which may be necessary to complete the construction.

The river crossing location on the bypass is unknown other than through records of performance of the adjacent CNR bridge. It is likely that a good direct approach cut can be made through both escarpments. These would lead to a perpendicular, short crossing of the river. If the smaller channel can be closed, the bridge can be of similar length to the existing Highway 16 bridge.

All roads on the flat lands are considered equal from a geotechnical perspective.

The estimated capital construction costs for the two options are presented in Table 13 (Highway 16 upgrade scenario) and Table 14 (bypass scenario).

(1) Restore old bridge to emergency and low volume daily service.

(2) A shorter bridge may be constructed if one of the river channels can be closed by diverting the water to the main channel. Also, this cost estimate is for only a two lane crossing of the Railway Avenue and the North Saskatchewan River on the bypass.

Table 15
Highway 16 Upgrade Versus Bypass Evaluation Rating

Item	Upgrade Existing Highway 16	Bypass With Highway 16
Environmental	7	6
Socioeconomic	7	7
Geotechnical	7	6
Topographical	7	7
Roadway Design	7	8
Traffic Warrants	8	6
General Impacts: Dangerous Goods Movement Upgrade Highway 16A Bridges	 2 8	 7 5
Subtotal	53	52
Costs	8	7
TOTAL	61	59

The access visibility for tourism and services for the current urban area will be more remote and therefore require additional signing to attract visitors. There will, however, be an increase in traffic safety and a reduction in congestion with the through bound non-stop trips removed from the traffic stream.

Through bound dangerous goods movements will be entirely removed from the urban area.

Other factors include an additional impact on the river valley and a less definitive solution to the old bridge question. There will be little impact on current river valley development plans except that tourists will be able to bypass the area without being directly presented with the river valley recreational opportunities.

The upgrade cost estimate includes both interchange options at Battleford Road and also the option of spending either $2.0 million or $0.8 million on the Highway 16A bridges. The bypass costs include both a long river crossing bridge and a short river crossing bridge. The most economical, least cost is the upgrading of existing Highway 16 with the minimum being spent on the Highway 16A bridges. The net present worth of this option is also the best, however, benefits do not equal costs at a forty year horizon and 5% discount rate. The internal rate of return for the bypass is greater which indicates the benefits are being accrued marginally faster on the bypass route. This is likely due to 4% approach grades to the river bridge and the low level of congestion on the bypass.

Dangerous goods movements favor the bypass as all thru bound movements can be diverted around the urban area. The upgrading of Highway 16 will maintain dangerous goods movements through the urban area and through at least three accident prone intersections and one tight radius curve.

Land severance for both the routes is nearly equal. The bypass has more impact as it is a new route and has large radius curves which create irregular land parcels.

The numeric evaluation of the foregoing is presented in Table 15 opposite. The upgrading is favored in the table resulting from a technical evaluation of the factors.

The recommendations for bypass versus upgrading on the existing alignment are as follows:

1. Implement the Highway 16 upgrading and do minimal work on the Highway 16A bridges.
2. The staging and warrants for the projects appear in Table 16 following.
3. The geotechnical feasibility studies on the north escarpment should begin immediately. The question of what should be contemplated for interim upgrading based on traffic and accident warrants has been addressed. In the case where the proposed National Highway Policy is not implemented, some upgrading is warranted. These projects are presented in Table 17, following with the events which would trigger implementation.

The planning for the regional network in the area of the Battlefords has involved the review of numerous traffic and road situations. Recommendations have been made regarding further required feasibility studies which are to confirm that the whole upgrading scheme is feasible.

One significant issue could impact the long-term upgrading of Highway 16. Protection of the land is necessary for the twinning and the interchanges is required to ensure the complete project can be undertaken. Access to Highway 16 must be limited to only those locations which will ultimately become interchanges to avoid future access removal problems. Full functional designs should be completed to allow purchase of lands necessary to the project.

Table 16
National Highway Policy Upgrades

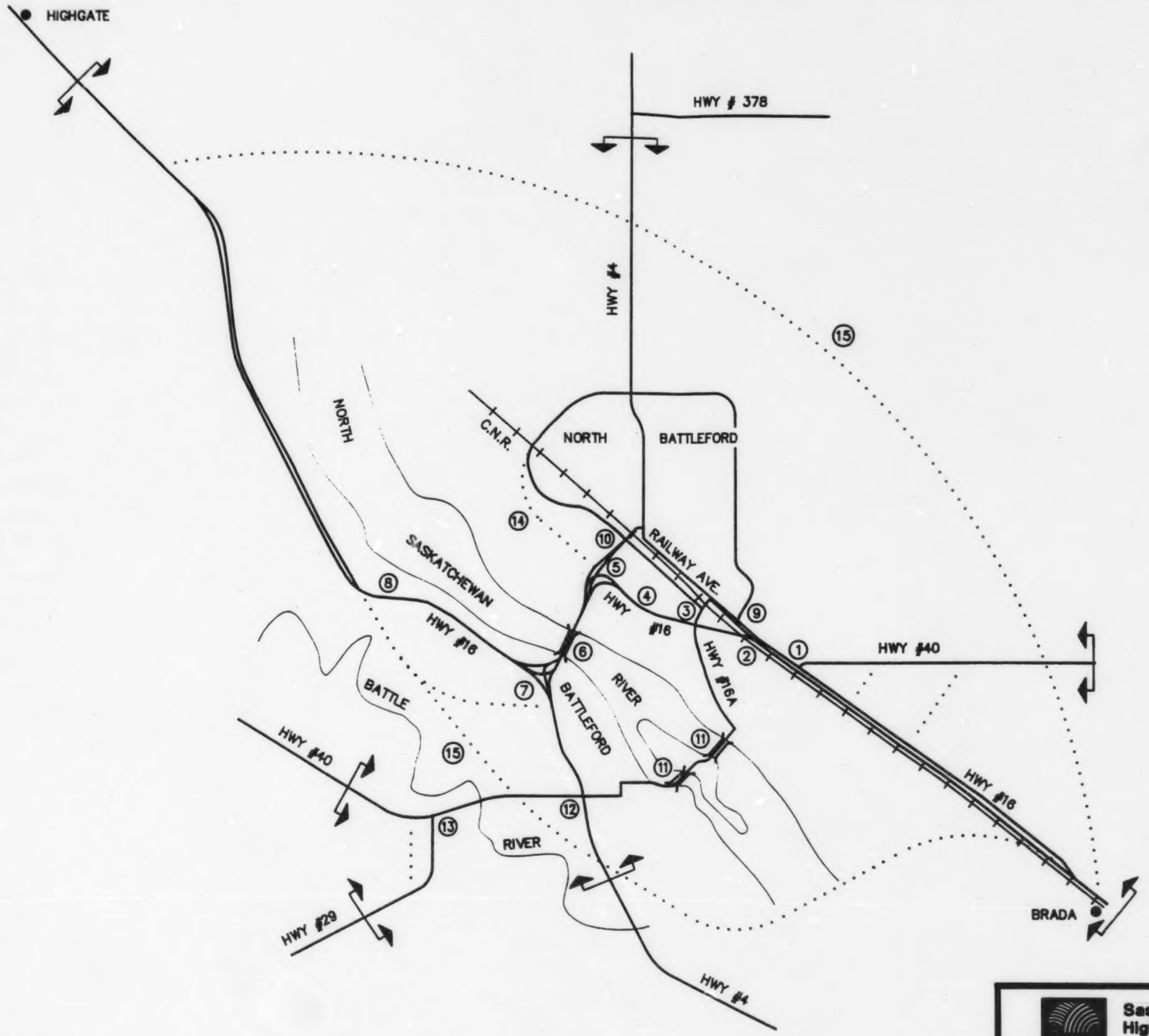
Location	Upgrades Required	Internal Staging	Program Staging	Estimated Capital Construction Costs	Triggers for Implementation
1. Relocation of Highway 40/ Highway 16 Intersection	Relocate Highway 40 to Aberdeen St. with stop sign operation. Right-in/Right-out Thatcher Dr. and Service Road. Extend Pioneer Ave.	1st	5th	$ 1,200,000	National Highway Policy. Need to provide free flow on Highway 16, otherwise, implement signals in short-term.
		1st		$ 900,000	
	Relocate Highway 16 to ultimate alignment.	1st or 2nd		$ 1,600,000	
	Implement interchange. Signalize intersections.	2nd	8th	$ 2,000,000 $ 200,000	LOS unacceptable for stop sign operation.
				$ 5,900,000	
2. Intersection of Highway 16 and 16 B (Railway Avenue)	Flyover for railway track and twinning of Highway 16 inbound and outbound ramps Highway 16B.	1st	6th	$ 4,600,000	National Highway Policy.
3. Intersection of Highway 16/ Battleford Road	Interchange - partial split diamond (or Territorial Dr. extension and interchange).	1st	7th (6th)	$ 6,500,000 $ (4,000,000)	National Highway Policy.
4. Twinning Highway 16 from 16B to the River Bridge	Included in 2 and 3 or implement extension of Thatcher Dr. and interchange if Battleford Road interchange not feasible.	1st 1st	7th	$ 4,000,000	National Highway Policy and decision not to implement Battleford Road interchange.
5. Ramp Highway 16WB to Highway 4NB	Do nothing.				
6. River Bridge Twinning	Flatten curves to achieve design speed. Build river bridge.	1st	1st	$ 7,000,000	Traffic volumes warrant immediate start.
7. Interchange Highway 16/ Highway 4/ Highway 40 South	Adopt Option 3S from previous report.	1st	3rd	$ 6,400,000	National Highway Policy.
8. Twinning Highway 16 (West)	Realign and twin to ultimate alignment.	1st	2nd	$ 3,000,000	National Highway Policy.
9. Intersection Highway 16B/ Territorial Dr.	Signalize, reduce speed limit on Territorial Dr.	1st		$ 100,000	Future traffic warrants.
10. Intersection Highway 16B/ Territorial Dr. (West)	Speed limit reduction. Four way stops.	1st 2nd		$ 2,500	Immediate if warranted.
11. Highway 16A Bridge	Upgrade for recreational use.	1st	4th	$ 800,000	After Highway 16 bridge twinning opens.
12. Intersection Highway 4/ Highway 40S	Do nothing or install centreline flashing lights.	1st		$ 50,000	If accidents increase in number or severity.
13. Intersection Highway 40/ Highway 29S	Do nothing.				Not warranted.
14. Relocate Territorial Dr. (West)	Do nothing.				Not warranted or economic.
15. Upgrade Existing Highway 16	Interchanges and twinning to achieve free flow conditions.			See component parts.	National Highway Policy.

Table 17
Traffic Warrant Upgrades

Location	Upgrades Required	Staging	Estimated Capital Construction Costs	Triggers for Implementation
1. Relocation of Highway 40/ Highway 16 Intersection	Signalize existing intersection. Relocate service road tie to Highway 40. Relocate to Hereford St. at-grade (stop signs). Extend Pioneer Ave. Signalize intersection.	1st 1st 2nd 2nd 3rd	$ 100,000 c/w advance warning lights $ 100,000 $ 1,200,000 $ 900,000 $ 100,000 c/w advance warning lights $ 2,400,000	LOS North Leg Development requires Highway 40 removal. LOS D or accident warrant.
2. Intersection of Highway 16 and 16B	Review traffic directional signing, curve warning signs, regulatory signing, street lighting intensities, pavement marking visibility.	1st	Depending upon upgrades required - $ 100,000 to $ 400,000	If accident warrants increase.
3. Intersection of Highway 16 and Battleford Road	Monitor traffic volumes & accidents. Signalize intersection c/w advance warning lights on Highway 16 approaches.	1st 2nd	$ 120,000	If 16A bridges closed. If 16A bridges remain open or re-routed 16A traffic develops warrant for signals.
4. Twinning Highway 16 From 16B to the River Bridge	Do nothing.			Not warranted.
5. Ramp Highway 16WB to Highway 4NB	Do nothing.			Not warranted.
6. River Bridge Twinning	Design and construct bridge within the next 5 years.	1st	$ 7,000,000	Traffic volumes warrant immediate start.
7. Interchange Highway 16/ Highway 4/Highway 40 South	Do nothing.			Not warranted.
8. Twin Highway 16 (West)	Do nothing.			Not warranted.
9. Intersection Highway 16B/ Territorial Dr.	Reduce speed on Territorial Dr. Signalize.	1st 2nd	$ 100,000	When warranted.
10. Intersection Highway 16B/ Territorial Dr. (West)	Speed limit reduction. Four way stops.	1st 2nd	$ 2,500	Immediate if warranted.
11. Highway 16A Bridge	Upgrade for recreational use.	1st	$ 800,000	After Highway 16 twin bridge opens.
12. Intersection Highway 4/ Highway 40S	Do nothing or install centreline flashing lights.	1st	$ 50,000	If accidents increase in number or severity.
13. Intersection Highway 40/ Highway 29S	Do nothing.			Not warranted.
14. Relocate Territorial Dr.	Do nothing.			Not warranted.
15. Upgrade Highway 16	Do nothing.			Not warranted.

APPENDIX A

EXHIBITS



LEGEND

- POTENTIAL HIGHWAY ROUTES
- STUDY LIMITS
- ④ SPECIFIC ISSUES LOCATIONS

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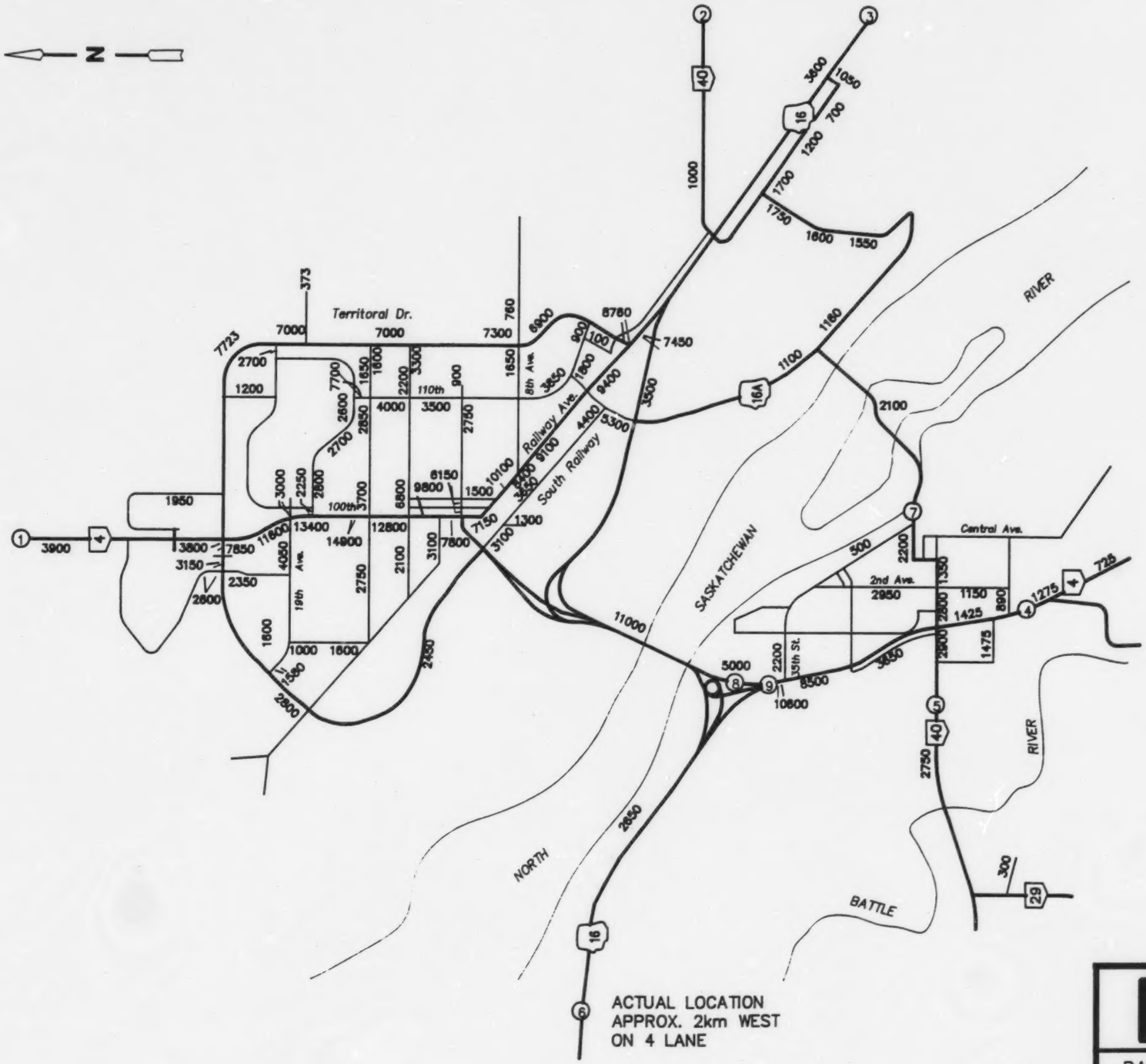
BATTLEFORDS REGION TRANSPORTATION STUDY

PROJECT LIMITS / IDENTIFICATION OF ISSUES

EXHIBIT 1



CORDON LOCATIONS

OCTOBER 20, 1992

② – HWY 40 EAST
③ – HWY 16 EAST
⑥ – HWY 16 WEST

OCTOBER 21, 1992

① – HWY 4 NORTH
④ – HWY 4 SOUTH
⑤ – HWY 40/29 WEST

OCTOBER 22, 1992

⑦ – OLD BATTLEFORDS BRIDGE
⑧ – NORTHBOUND RAMP
⑨ – SOUTHBOUND RAMP

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BATTLEFORDS REGION TRANSPORTATION STUDY

TWO–WAY DAILY TRAFFIC VOLUME COUNTS

EXHIBIT 2

N

Clements Dr.

Douglas Ave.

Territorial Dr.

19th Ave.

15th Ave.

11th Ave.

9th Ave.

8th Ave.

5th Ave.

Kilfoss Dr.

NORTH

SASKATCHEWAN

South Railway

Jersey St.

35th St.

28th St.

2nd Ave.

Central Ave.

BATTLE

RIVER

RIVER

LEGEND

- RESIDENTIAL
- INDUSTRIAL
- COMMERCIAL – Retail + Office
- INSTITUTIONAL
- (18) MODEL ZONE

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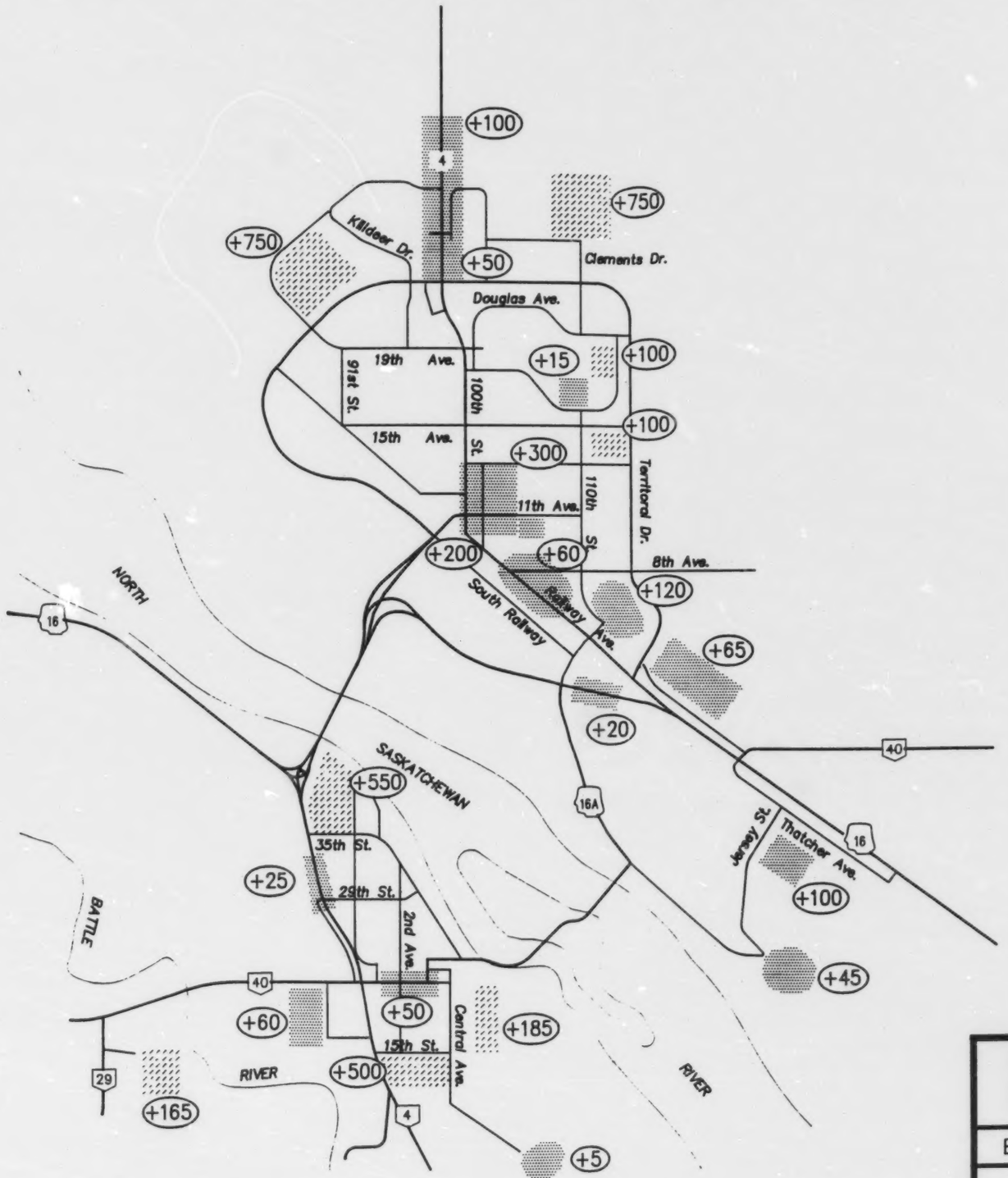
BATTLEFORDS REGION TRANSPORTATION STUDY

INTERNAL ZONE MAP

EXHIBIT 3



LEGEND

20 YEAR Population Growth +3200

20 YEAR Employment Growth +1325

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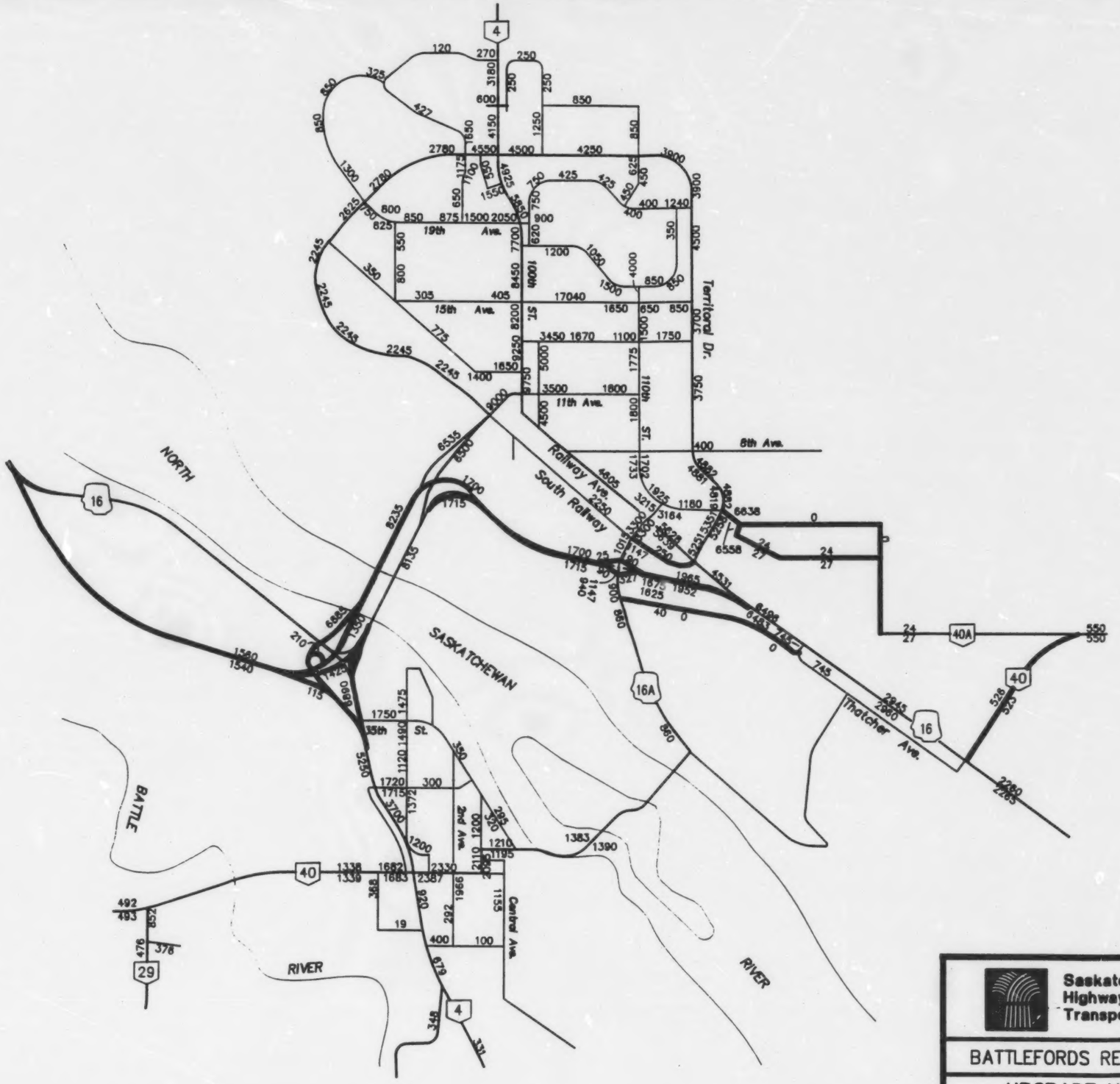
BATTLEFORDS REGION TRANSPORTATION STUDY

AREAS OF EXPECTED GROWTH

EXHIBIT 4



LEGEND

PROPOSED OR TWINNING OF EXISTING ROADS

EXISTING ROADS

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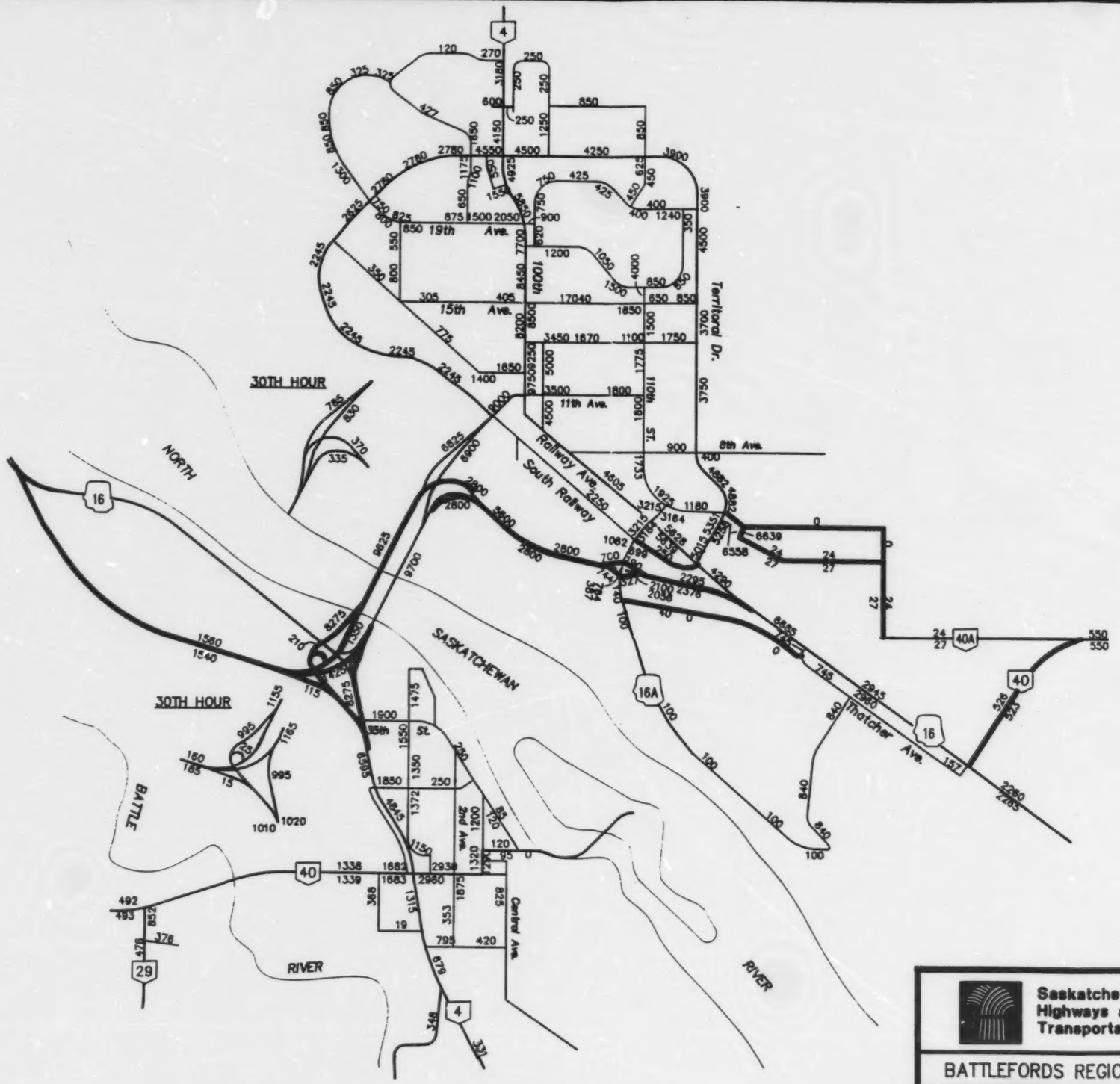
BATTLEFORDS REGION TRANSPORTATION STUDY

UPGRADE HWY 16 c/w 16A BRIDGE
FUTURE TRAFFIC VOLUMES – AADT

EXHIBIT 5



LEGEND

- PROPOSED OR TWINNING OF EXISTING ROADS
- EXISTING ROADS

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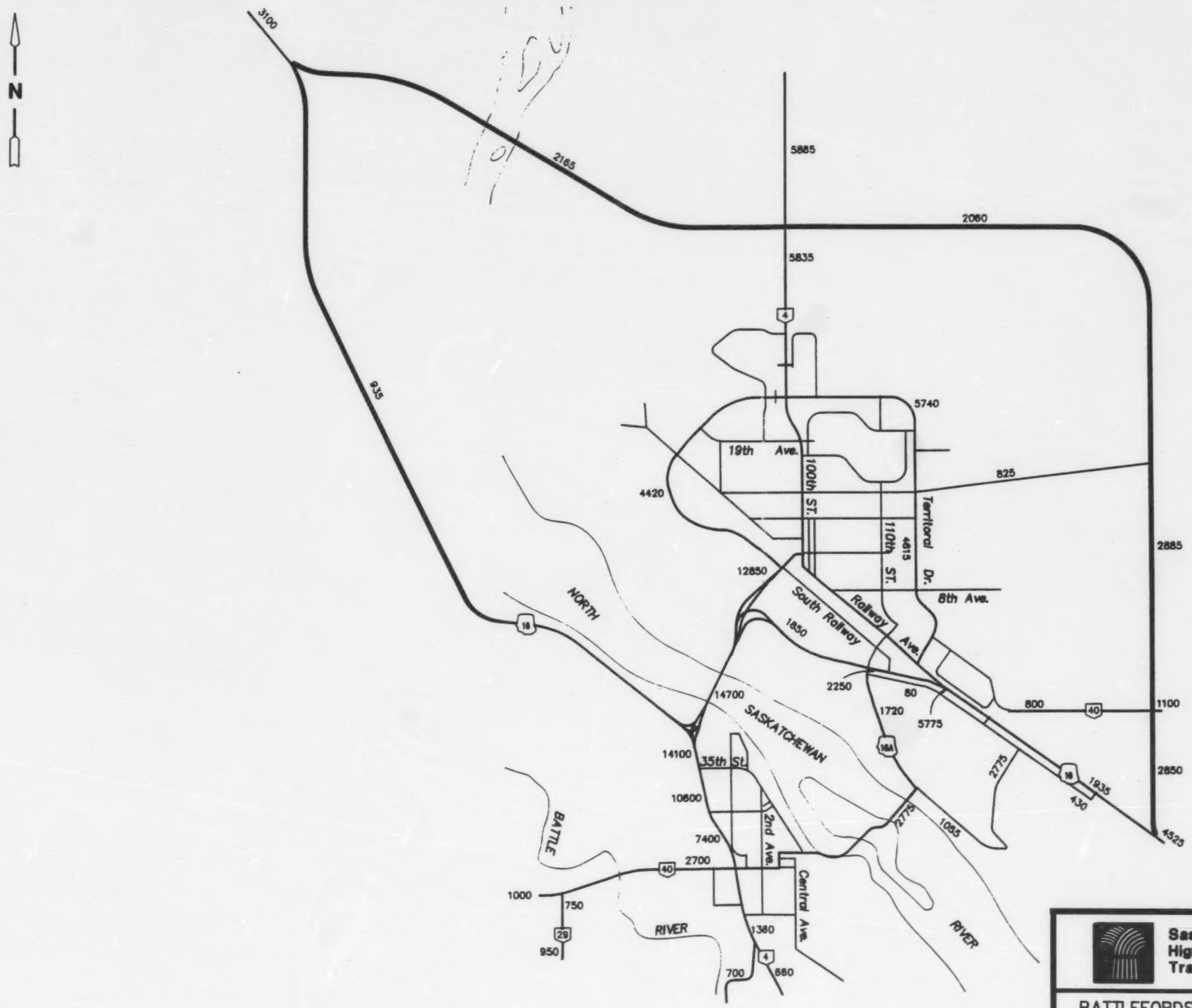
BATTLEFORDS REGION TRANSPORTATION STUDY

UPGRADE HWY 16 WITHOUT 16A BRIDGE
FUTURE TRAFFIC VOLUMES – AADT

EXHIBIT 6


N
3100
2165
5885
2060
5835
4
5740
19th Ave.
100th ST.
110th ST.
4613
Territorial Dr.
825
4420
12850
8th Ave.
South Railway
Railway Ave.
1850
2250
80
1720
5775
800
40
1100
2885
2850
4525
1935
430
2775
2775
1055
16A
16
NORTH
SASKATCHEWAN
14700
14100
35th St.
10600
2nd Ave.
7400
2700
40
Central Ave.
1380
4
700
660
BATTLE
RIVER
RIVER
1000
750
29
950
LEGEND
PROPOSED OR TWINNING OF EXISTING ROADS
EXISTING ROADS
Saskatchewan Highways and Transportation
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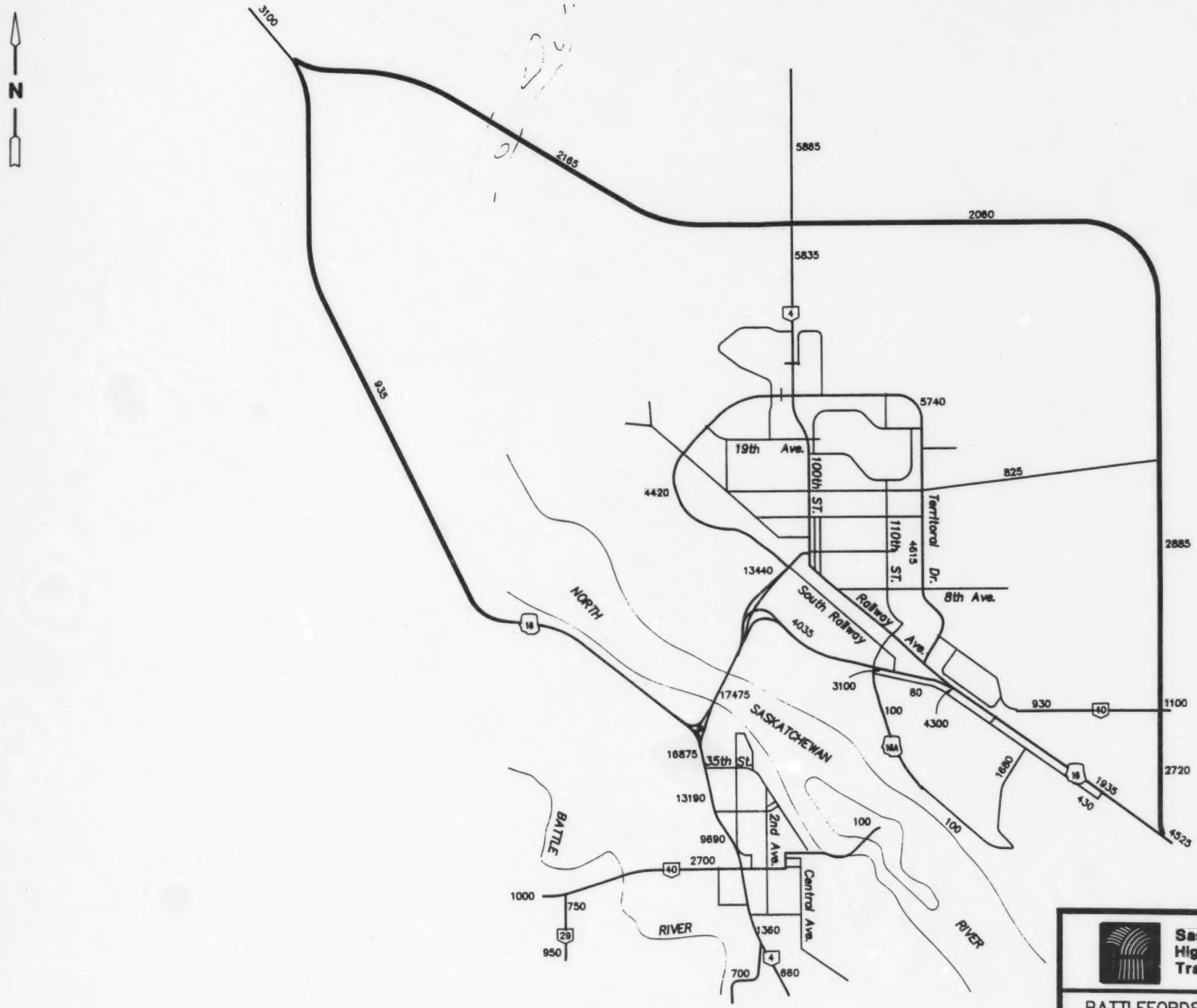
BATTLEFORDS REGION TRANSPORTATION STUDY
EXHIBIT
7
BYPASS – FUTURE TRAFFIC AADT



LEGEND

PROPOSED OR TWINNING OF EXISTING ROADS

EXISTING ROADS

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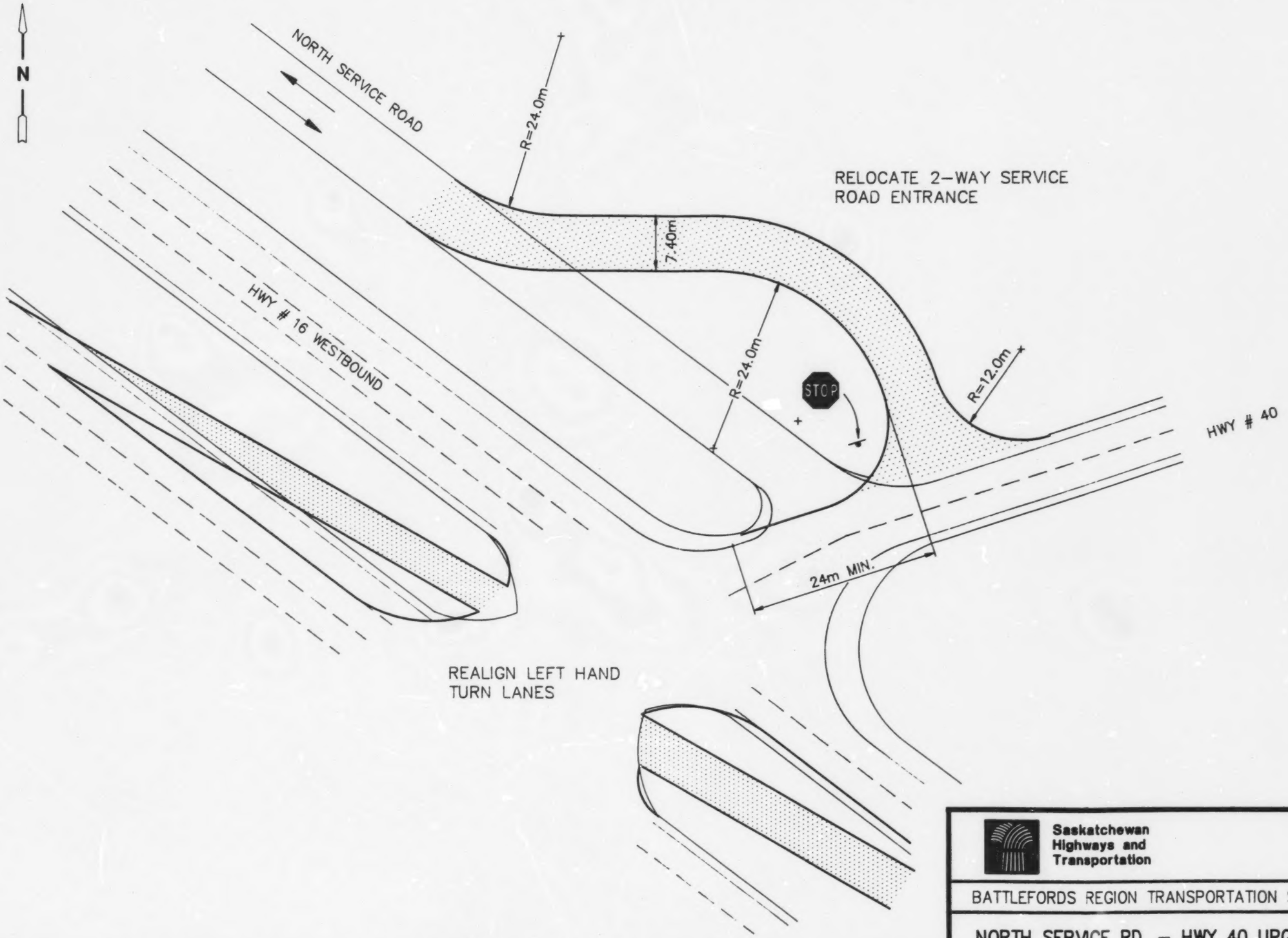
BATTLEFORDS REGION TRANSPORTATION STUDY

BYPASS (16A BRIDGE CLOSED)
FUTURE TRAFFIC VOLUMES – AADT

EXHIBIT
8



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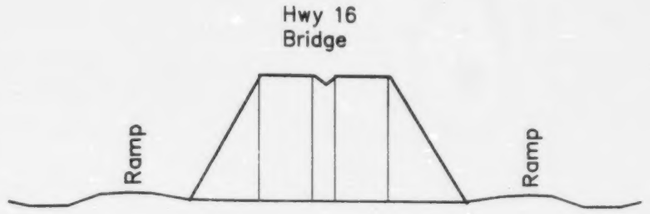
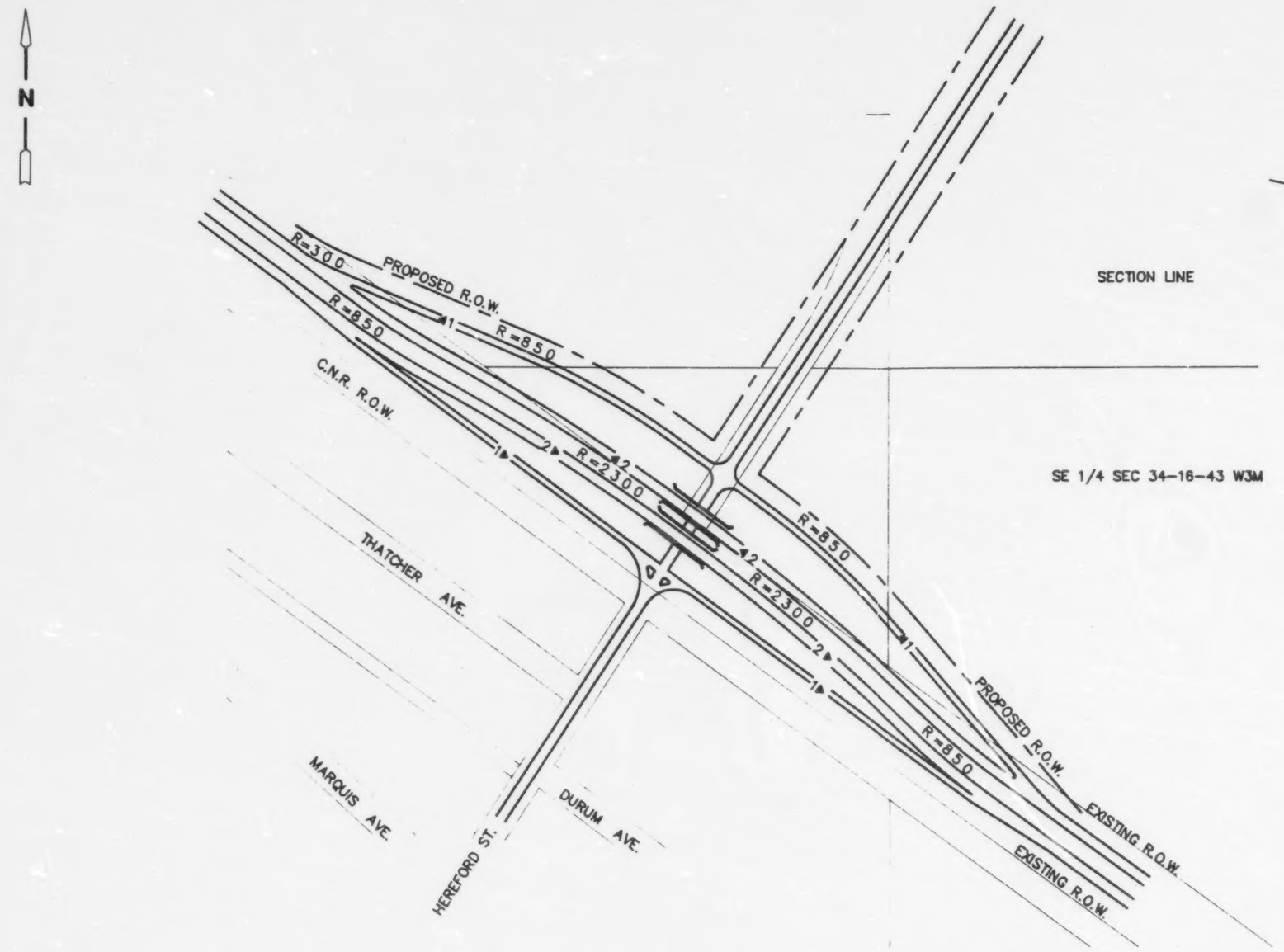
BATTLEFORDS REGION TRANSPORTATION STUDY

NORTH SERVICE RD. – HWY 40 UPGRADE

EXHIBIT 9





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25m 125m

SCALE = 1:5000

Option 2
Hwy 16 over Hwy 40
Re–align Hwy 16

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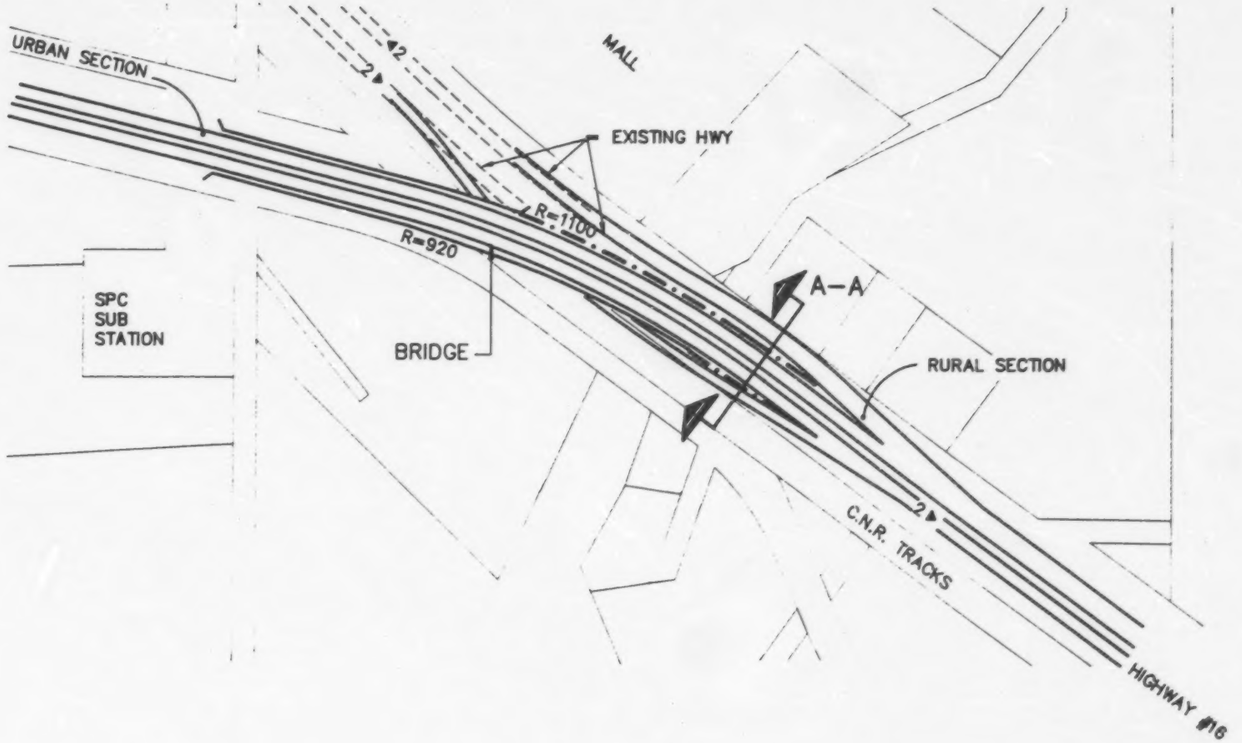
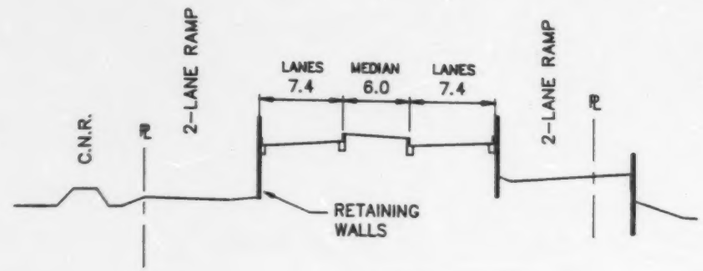
BATTLEFORDS REGION TRANSPORTATION STUDY

INTERSECTION HWY 16 & 40 – HEREFORD ST.

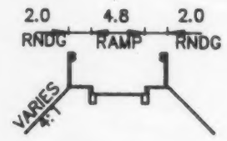
EXHIBIT 10



URBAN HIGHWAY 16



A–A



URBAN RAMP

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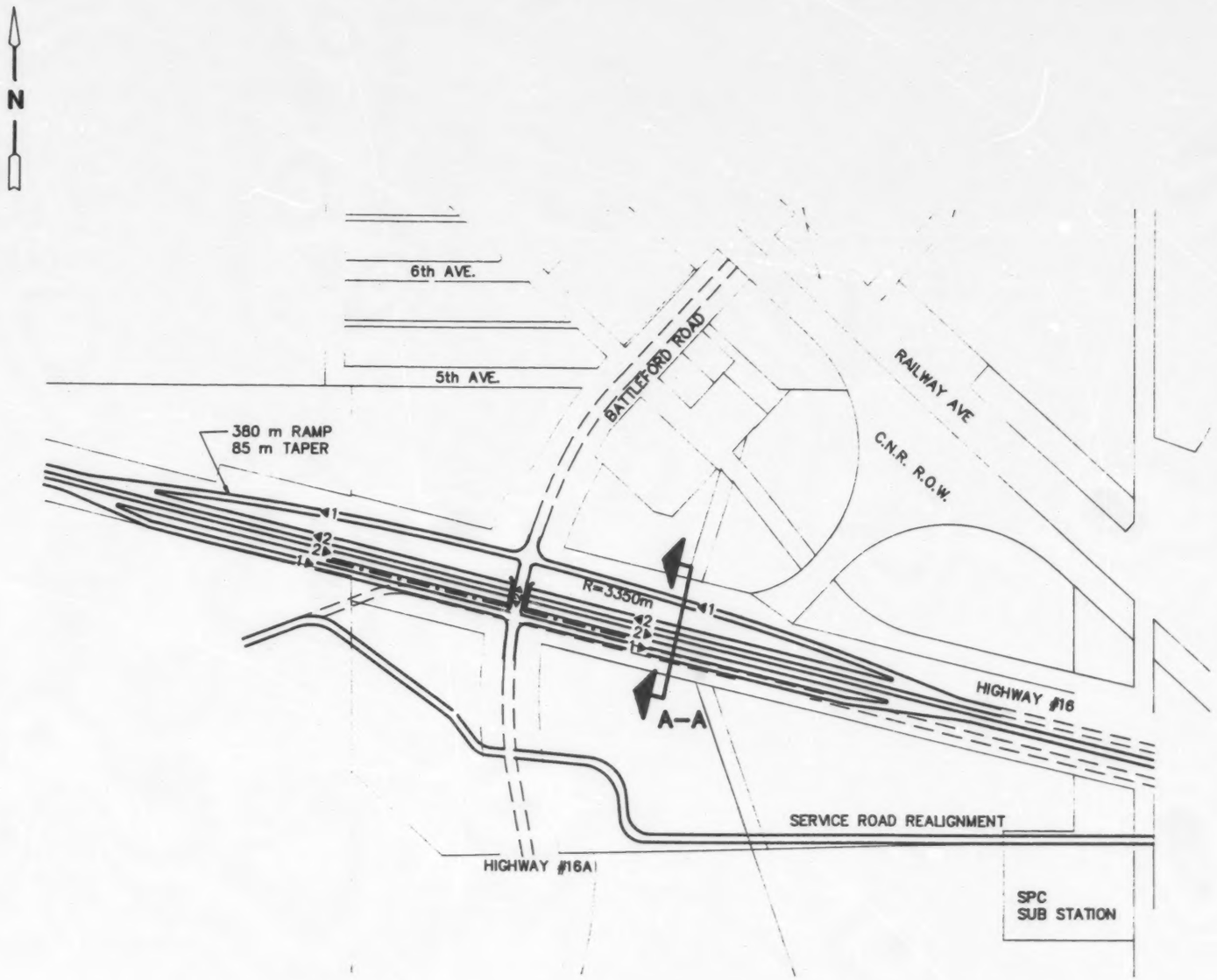
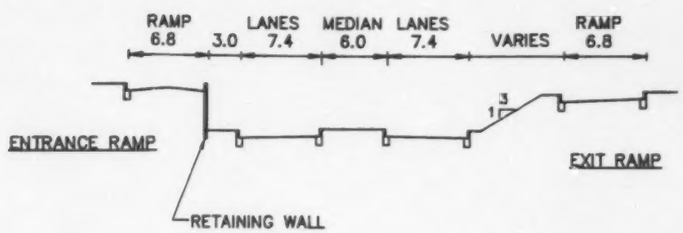
BATTLEFORDS REGION TRANSPORTATION STUDY

HIGHWAY 16 FLYOVER – CNR CROSSING

EXHIBIT 11



URBAN HIGHWAY 16



A–A

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SCALE = 1:5000

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BATTLEFORDS REGION TRANSPORTATION STUDY

HIGHWAY 16 – BATTLEFORD RD. DIAMOND INTERCHANGE

EXHIBIT 12

N

HIGHWAY #16

2
2
1

BATTLEFORD ROAD

RAILWAY AVE.

C.N.R. R.O.W.

TERRITORIAL DRIVE

FUTURE PIONEER AVE.

2
2

R=200

MALL

2
2
1

PROPOSED SERVICE ROAD

A–A

URBAN SECTION

SPC SUB–STATION

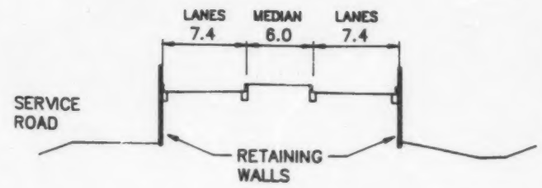
PROPOSED SERVICE ROAD

RETAINING WALLS

1

RURAL SECTION

URBAN HIGHWAY 16



A–A

0 50m 250m

25m 125m

SCALE = 1:5000

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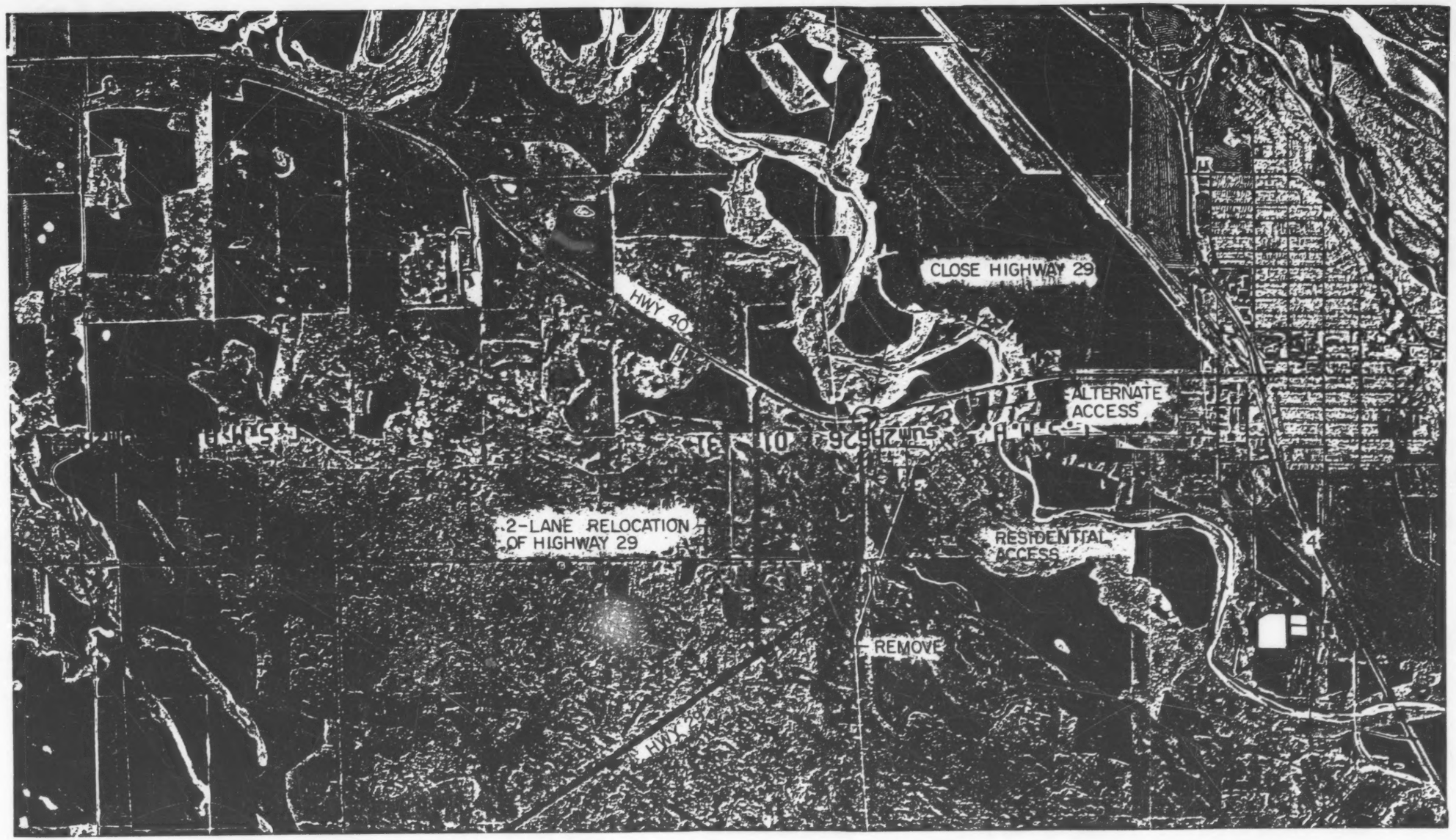
BATTLEFORDS REGION TRANSPORTATION STUDY

TERRITORIAL DR./HIGHWAY 16 INTERCHANGE

EXHIBIT 13



Saskatchewan Highways and Transportation

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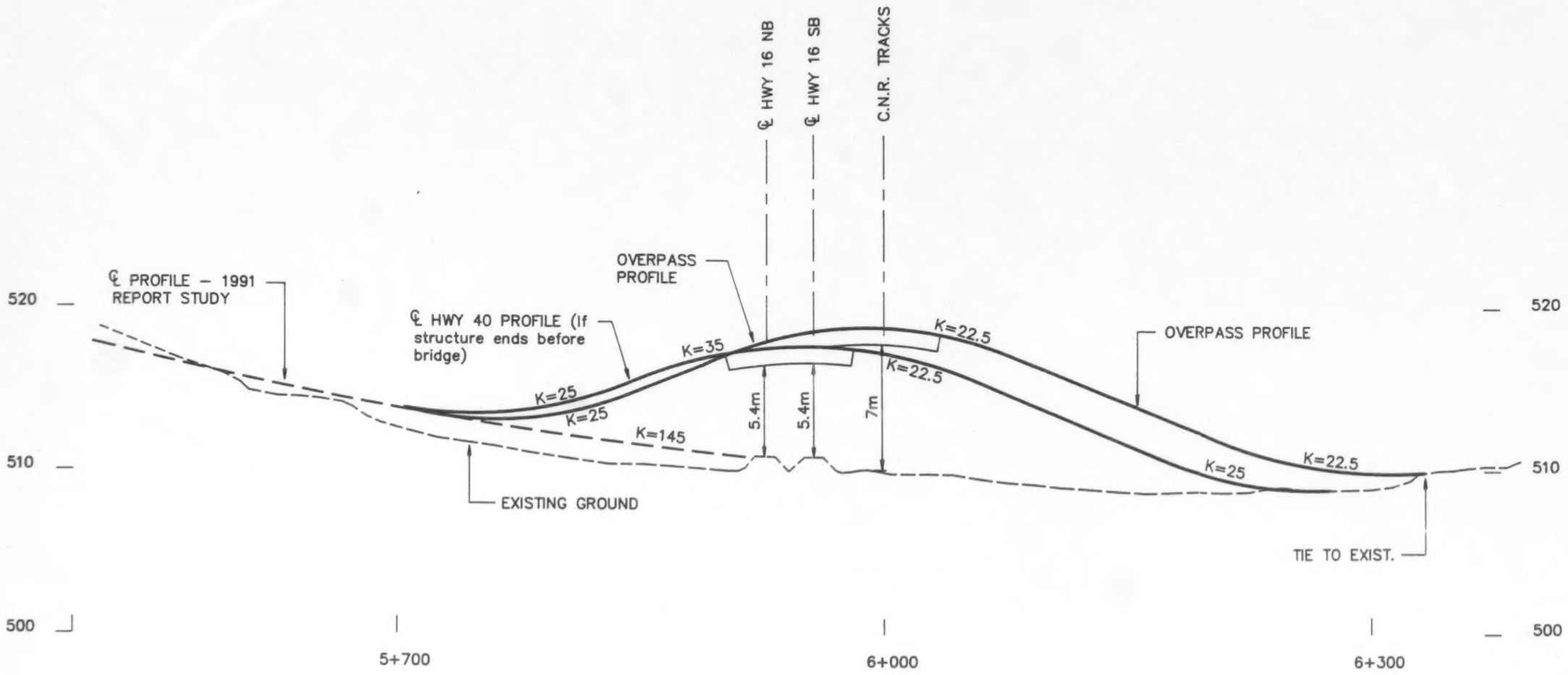
BATTLEFORDS REGION TRANSPORTATION STUDY

HIGHWAY 29 RE-ALIGNMENT

EXHIBIT 14



OVERPASS

- DESIGN SPEED 100kph
- Kcrest 70
- Ksag 40

RAMP

- DESIGN SPEED 80kph
- Kcrest 35
- Ksag 30

Saskatchewan Highways and Transportation

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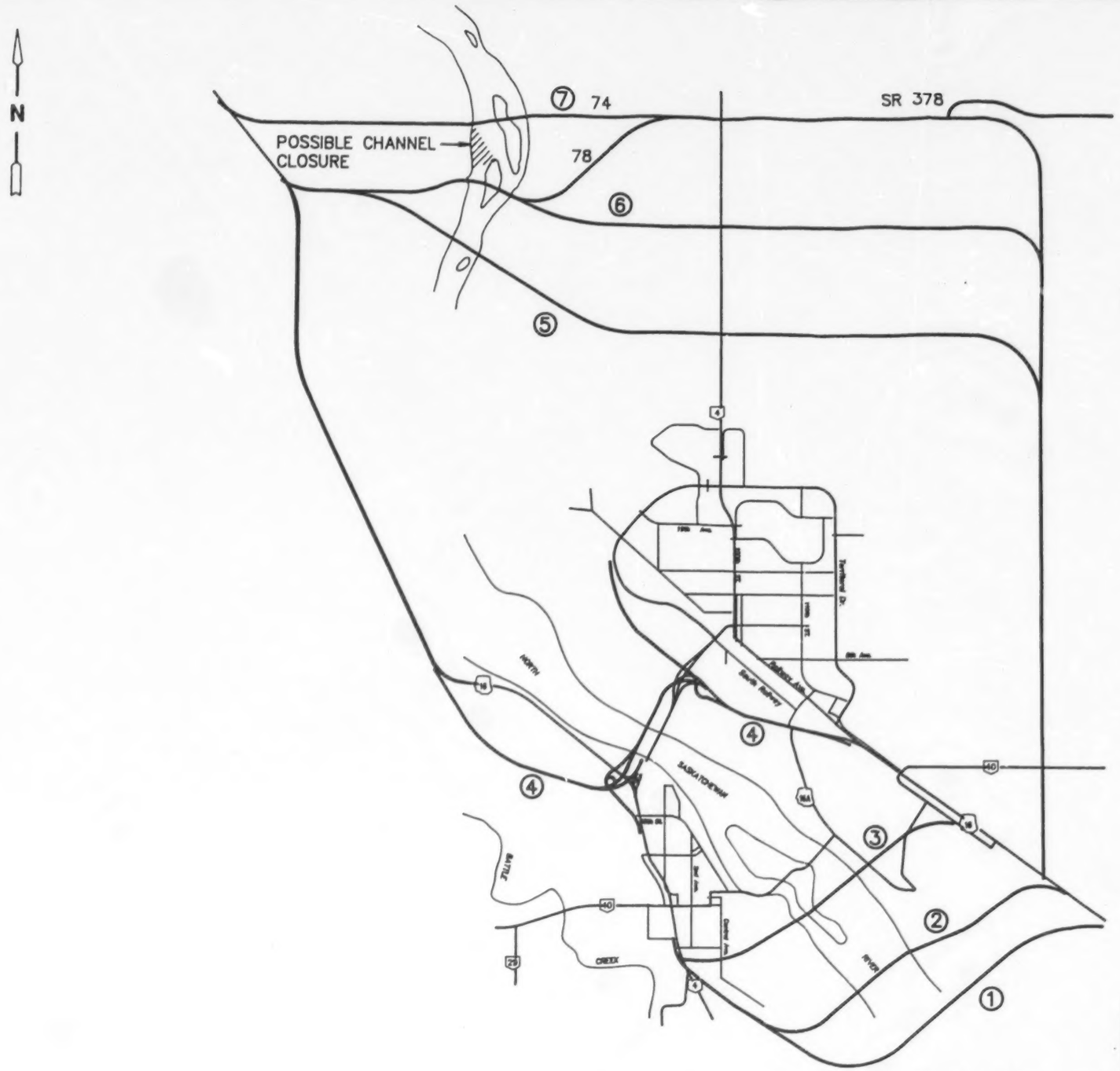
BATTLEFORDS REGION TRANSPORTATION STUDY

HWY 40 OVER HWY 16 AT ABERDEEN ST.

EXHIBIT 15



Saskatchewan Highways and Transportation

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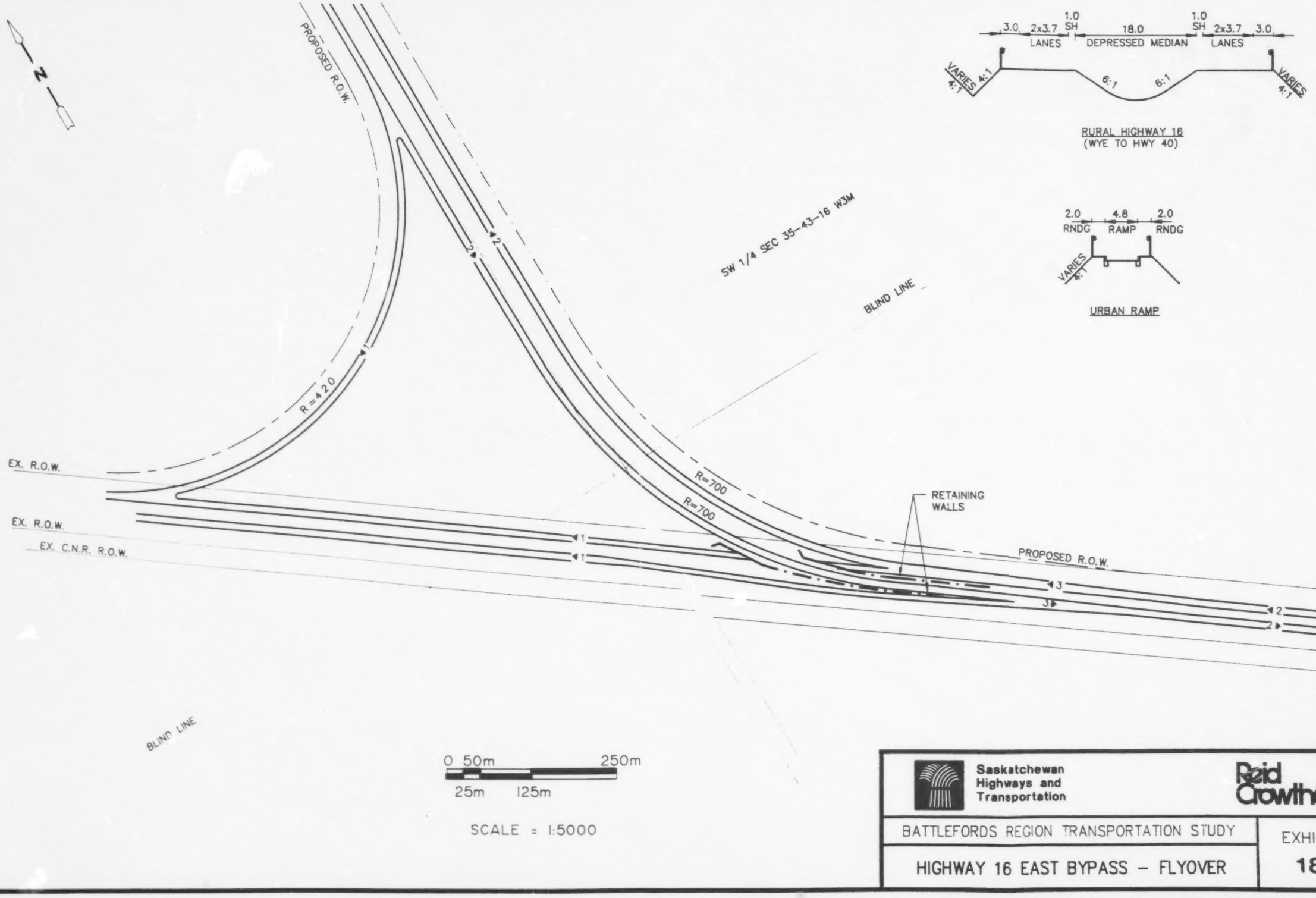
BATTLEFORDS REGION TRANSPORTATION STUDY

PRELIMINARY HIGHWAY OPTIONS

EXHIBIT 16



RURAL HIGHWAY 16
(WYE TO HWY 40)

URBAN RAMP

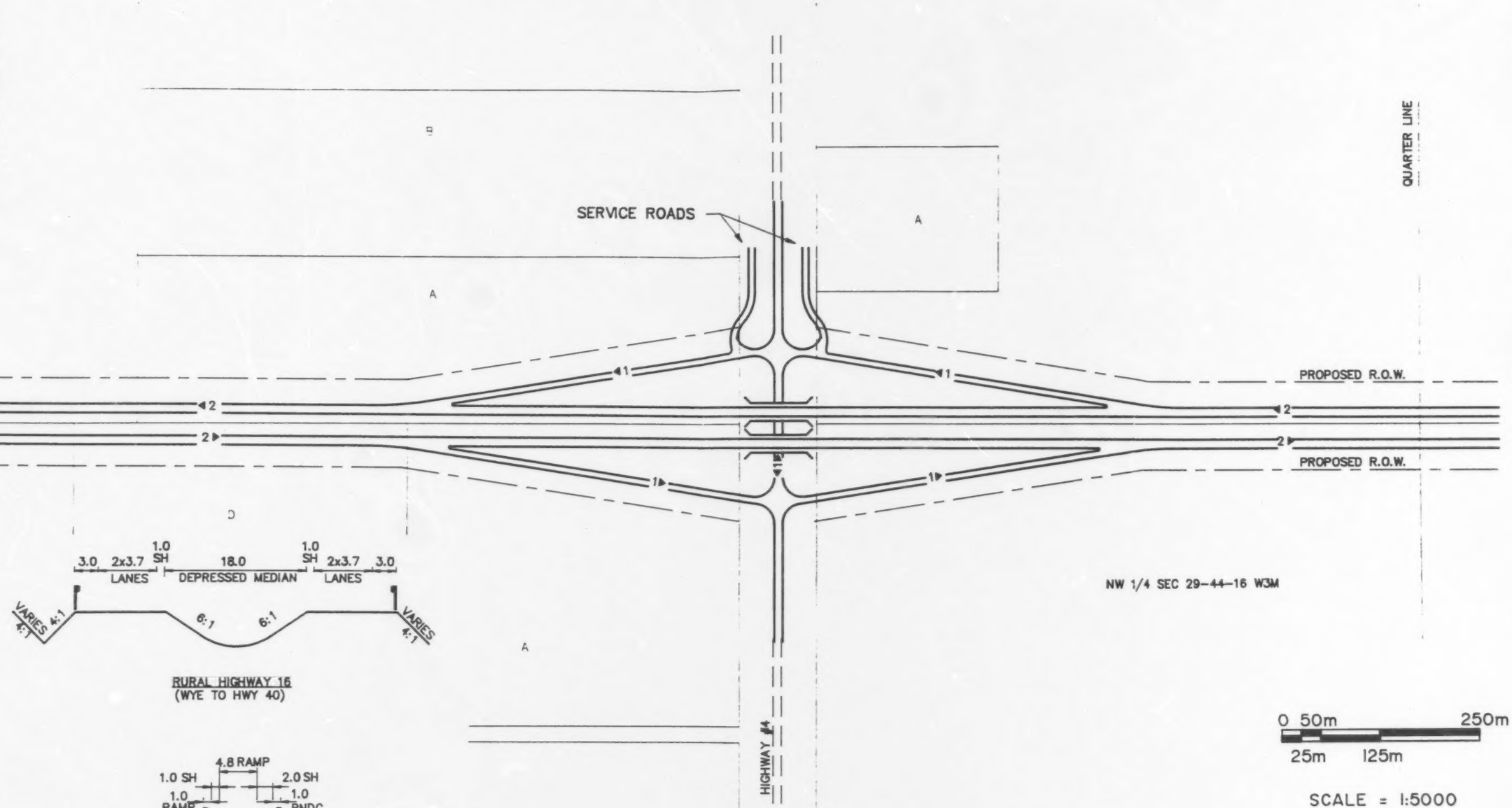
Saskatchewan Highways and Transportation

Reid Crowther

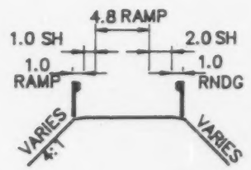
BATTLEFORDS REGION TRANSPORTATION STUDY

HIGHWAY 16 EAST BYPASS – FLYOVER

EXHIBIT 18



RURAL HIGHWAY 16
(WYE TO HWY 40)



RURAL RAMP

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HIGHWAY 16/4 – DIAMOND INTERCHANGE

EXHIBIT 19